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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE
AMERICAN MACHINIST PUBLISHING CO.,
256 BROADWAY, NEW YORK.

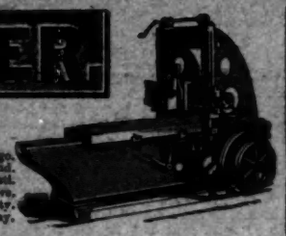
Some Leading Articles in this Number.

Cooling Water for Condensing Engines.
Making Bicycle Wheel Hubs.
A Stone Planer.
Power Calculations for Traveling Cranes.
Building a Great Dynamo.
Firing Dust Fuel.
Fastening Fly Wheels.
The Piston Valve.
Standard Screw Threads.
Cost of Operating Air Hoists.

NINETEENTH YEAR.

No. 14.
April 2,
1896.

THE GRAY PLANER



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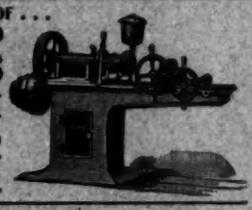

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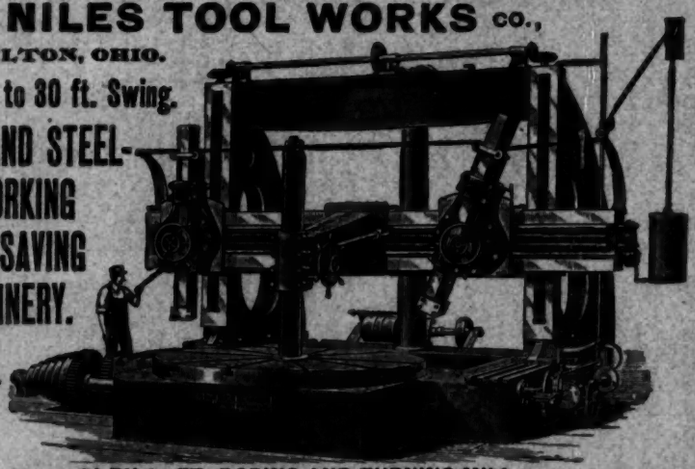

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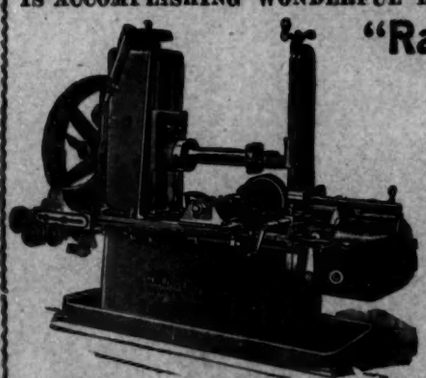

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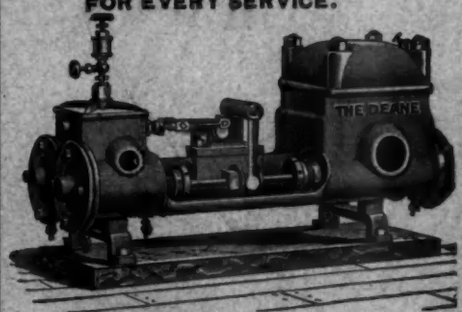

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A Stone Planer.

We take pleasure in laying before our readers a half-tone with some shop drawings of details of a planer for cutting stone. It will be found interesting in many particulars.

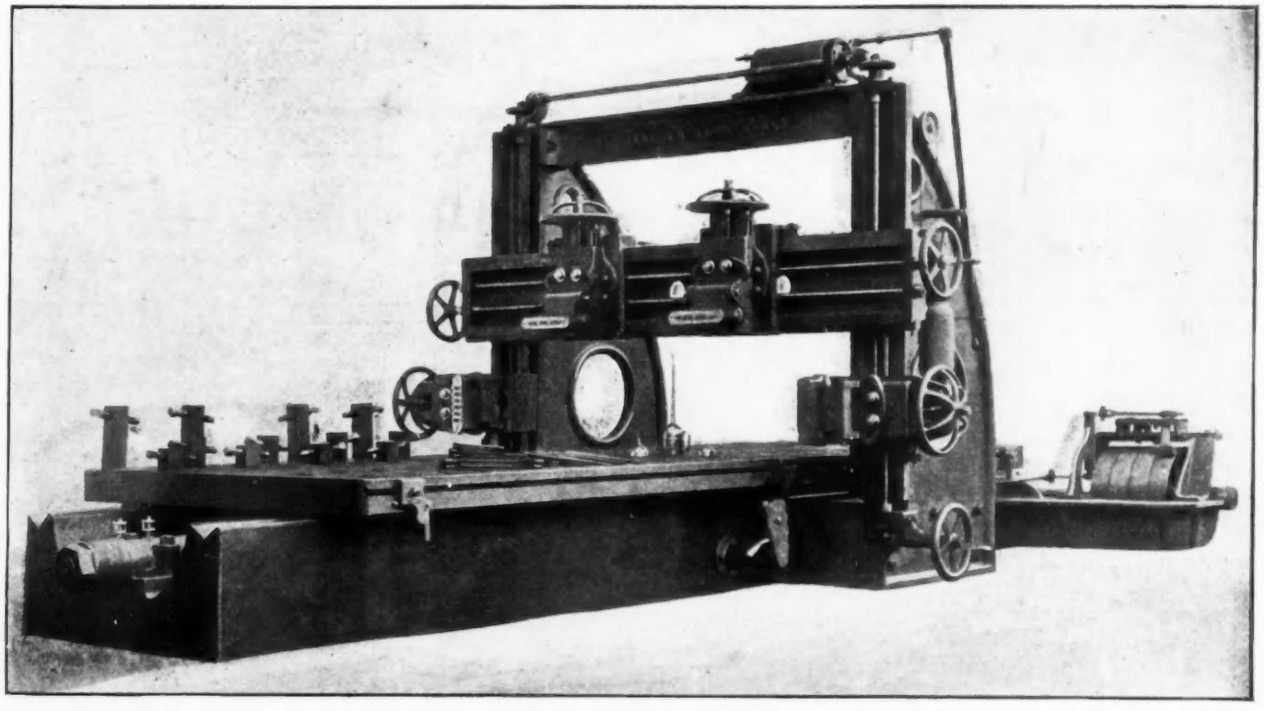
Quarrying and dressing stone for building or monumental purposes has, like other arts, been transformed by the touch of invention and the application of machinery. The stone is no longer got out by the drilling of a few holes, and then blasting and trusting to luck as to the sizes and shapes of the pieces obtained. Channeling machines define in the native bed the precise shape and dimensions of the piece to be got out with great accuracy. Channels are cut in the rock vertically at the back of the block and horizontally in under it, when it may be easily split off by means of wedges. After the block is got out, the surfaces are now quite generally cut and finished by suitable machines instead of by hand, as has until modern times been the universal practice since the time of the Tower of Babel, and the obelisks of Egypt. Large lathes and vertical spindle mills now turn the heaviest columns and other circular work, and planers dress the surfaces of the rectangular blocks or those of rectilinear outline.

The planer which we illustrate is 72″ x 48″ x 14′. To eyes accustomed to the sight of planers for metal work, there will appear in this machine some marked peculiarities. The machine has no feed motion, either vertical or horizontal. A man stands right over the work and feeds the tool along according to his judgment for every stroke of the planer. Where window sills or similar pieces are to be planed, they are usually planed in pairs, one on each side of the machine, with a man for each, the tool carriers being moved independently as required. The tool holder does not look familiar; a wider space is provided for the tools than is required for metal planing. The several set screws make it possible also to use a number of different tools at once, which is often necessary in shaping moldings or in finishing broad surfaces.

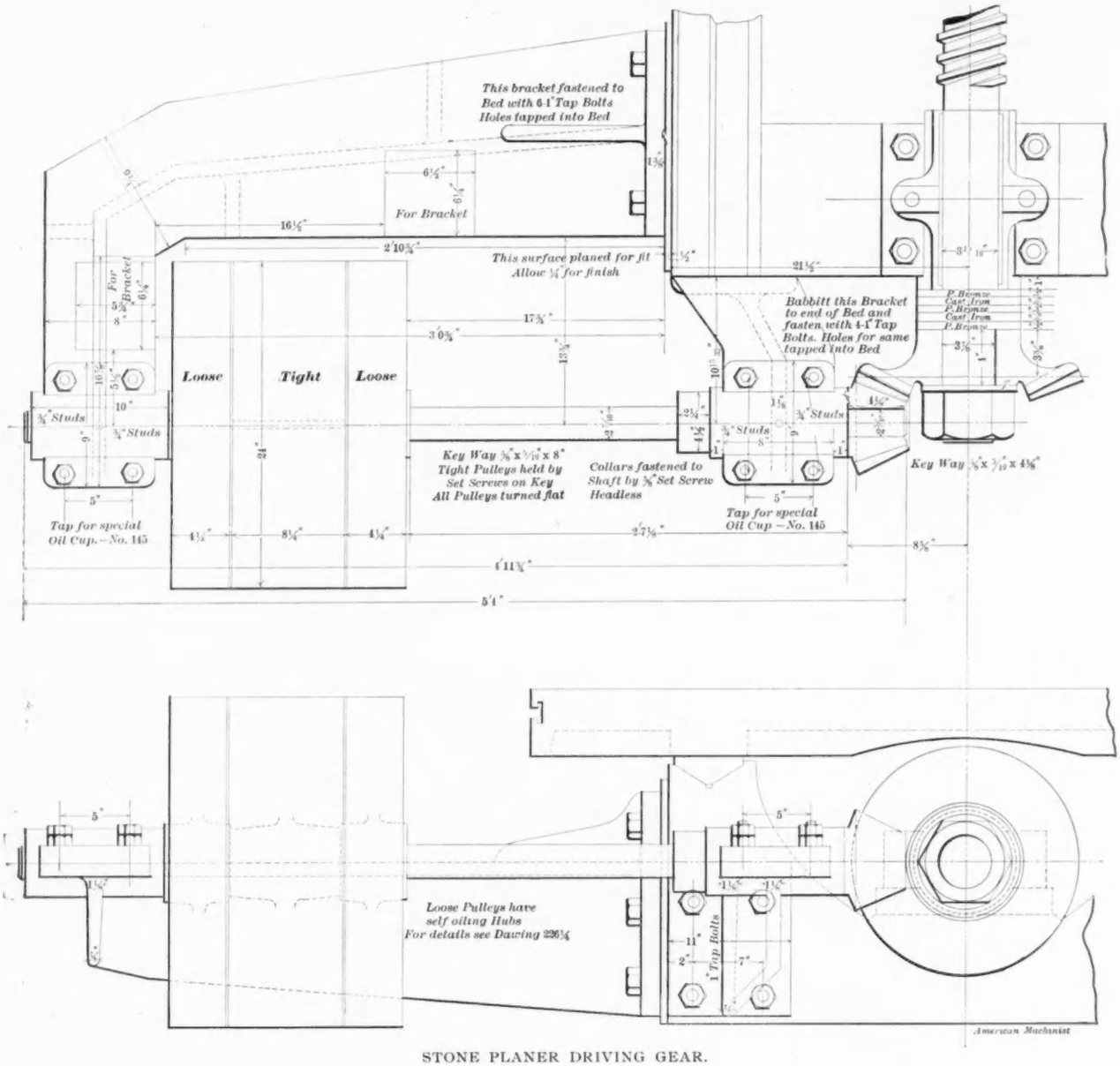
There are no arrangements upon the platen for securing the work by bolts. The stones are held almost exclusively by stakes and set screws, a number of them being shown standing in the platen. This mode of holding work should be adopted for iron and steel work more generally than it is.

The drawings which we reproduce of the driving-gear details require no explanation. They embrace no novelty, but will still be of interest to designers and constructors of machine tools.

We append sketches of a number of the tools used, which give a good idea of the general practice in cutting stone upon the planer. The practice of the leading yards in the East seems to be to use a kind of scraper tool for almost all kinds of work, even that of plane surfacing, while in the



A STONE-PLANER MACHINE.


This bracket fastened to Bed with 6-1" Tap Bolts Holes tapped into Bed
For Bracket
This surface planed for fit Allow ¼" for finish
Babbitt this Bracket to end of Bed and fasten with 4-1" Tap Bolts. Holes for same tapped into Bed
Loose
Tight
Loose
¾" Studs
Key Way ⅝" x 7/16" x 8" Tight Pulleys held by Set Screws on Key All Pulleys turned flat
Collars fastened to Shaft by ⅝" Set Screw Headless
Key Way ⅝ x 7/16" x 4⅛"
Tap for special Oil Cup.—No. 145
Loose Pulleys have self oiling Hubs For details see Dawing 2361¼
1 Tap Bolts
American Machinist

STONE PLANER DRIVING GEAR.

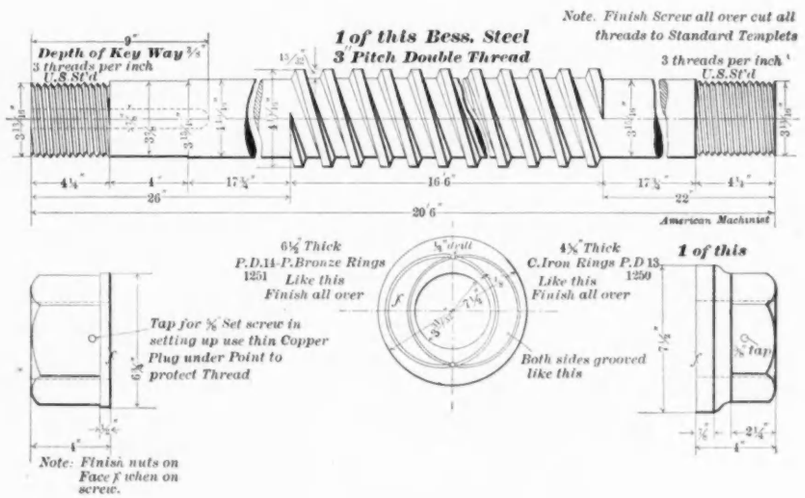
West the tools are made more like iron-working tools.

The common grades of tool steel seem to be good enough for this work. The tools are made ¾ inch to 1 inch deep, fore and aft—usually the latter—and they vary in width from 1 inch to 6 inches, according to the work.

Sketch No. 1 shows a form of tool used in Eastern yards for plane surface work, the same style of tool being used for both roughing and finishing cuts.

Sketch No. 2 shows the style of tool used in the West for all roughing work and much finishing. If a wide tool is desired of No. 2 style, it is made by placing two 7-inch tools side by side, the tool stock being made much wider on machines for the Western trade than on those for the East.

In many cases where bridge or wall work is being gotten out, especially when planers are located at the quarry, where

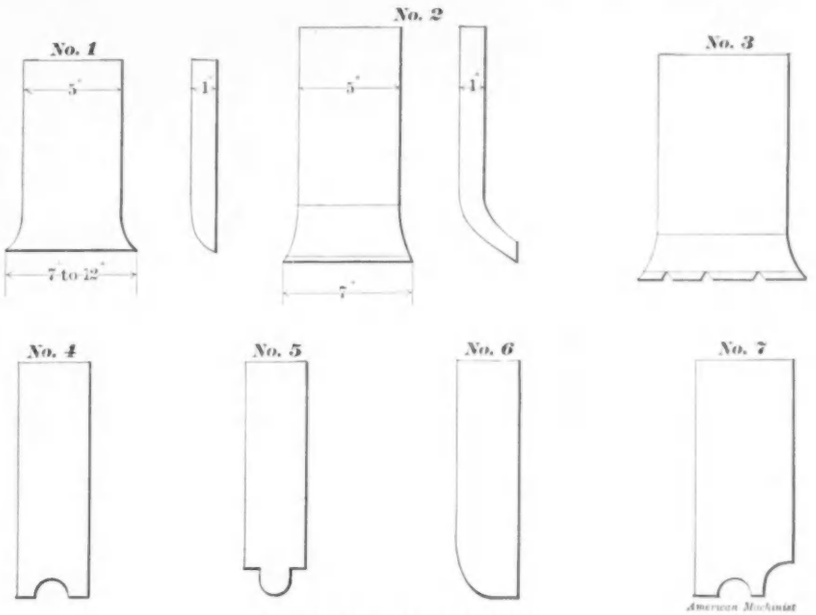

Note. Finish Screw all over cut all threads to Standard Templets
1 of this Bess. Steel 3 Pitch Double Thread
Depth of Key Way ⅜ 3 threads per inch U.S.St'd
3 threads per inch U.S.St'd
American Machinist
6½" Thick P.D.14-P.Bronze Rings 1251 Like this Finish all over
4⅝" Thick C.Iron Rings P.D 13. 1250 Like this Finish all over
1 of this
Tap for ⅜ Set screw in setting up use thin Copper Plug under Point to protect Thread
Both sides grooved like this
Note: Finish nuts on Face f when on screw.

STONE PLANER SCREW DETAILS.

stock is not of great value, it is customary to quarry as near finished dimensions as possible and then remove the surplus stock entirely in the planer, instead of sawing down to nearly the finished size and thus saving the slab cut off. When this is practical, tools of the form shown in No. 2 are used; but the edge of the tool is notched as per sketch No. 3, for the purpose of breaking up the chips smaller.

It would seem that the tools shown in No. 2 must cut easier than No. 1; but for molded work requiring tools like Figs. 4, 5, 6 and 7, the forging of tools in shape No. 2 would be difficult, and the sharpening a great expense as compared with that of grinding style No. 1.

We recently saw one of these machines in operation in this city. The work going on was the planing the front of blocks of stone about 6 feet long and less than 1 foot square. The stones, one on each side of the planer, with a man for each, were held by screws thrusting against each end. The shape required for the finished face was indicated by a profile of about a quarter of an inch in width, which had been chipped by hand upon the back end, so that no templates were used to guide the shaping. The stone was the white limestone now so commonly used for facing buildings in this locality, and it cuts apparently as easily as cheese, no temper being required for the tools. We were shown some tools shaped by a file which had been used off and on all day, and which showed no signs of wear. The rapidity with which the work was being done suggested that it must be almost incomparably faster than hand work, although upon other kinds of stone the advantage must be much less. Marble is usually planed wet to prevent the overheating of the tools.



TOOLS FOR STONE PLANER.

The planer shown is built by the Lincoln Iron Works, Rutland, Vt., and we are indebted to that firm for much valuable information in connection with the above topic.

▲ ▲ ▲

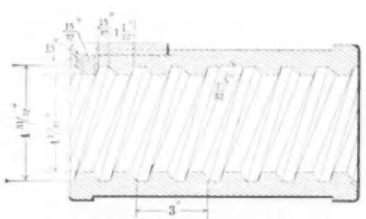
Electric Motors on Brooklyn Bridge.

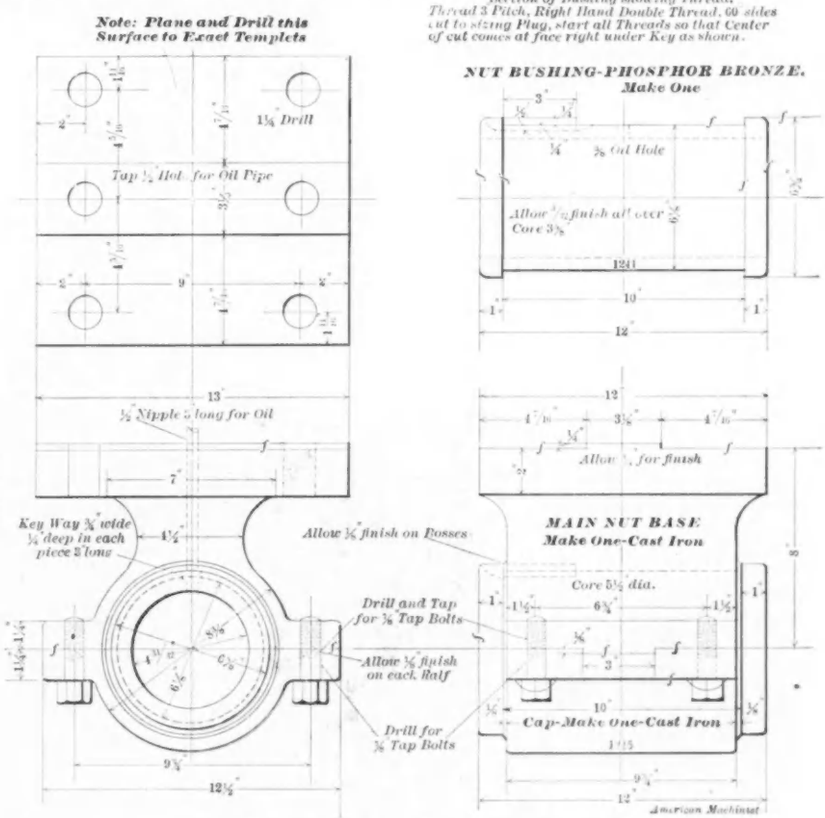
The Trustees of the New York and Brooklyn Bridge have determined to substitute electric motors for the steam locomotives heretofore used for switching the passenger trains to the return track at each end of the bridge. It is supposed that in six months from this writing the new arrangement will be in full operation. The noise, steam and cinders of the old engines will be got rid of, and it is expected that some time will be gained in the switching, although it is difficult to see why there should be any advantage in this respect, other things being equal.

A power house 100 feet square is to be built, and 2,500 horse-power of boilers installed, with engines and dynamos as may be required, the installation to cost $300,000. Sixteen motors are to be equipped; they will be used for all the switching at the terminals, and will be always ready for bridge traction in case of accident to the cable, although it is not at present expected that the cable will be abandoned.

▲ ▲ ▲

When a second bridge is completed, at only a short distance from the present one, it may be expected that the competitions or comparisons that will arise may lead to other changes; so that any present arrangement is more or less provisional. In the present rapid progress of invention in the line of traffic appliances, it is not safe to predict the ultimate arrangement.


Section of Bushing showing Thread.
Thread 3 Pitch, Right Hand Double Thread, 60 sides cut to sizing Plug, start all Threads so that Center of cut comes at face right under Key as shown.


Note: Plane and Drill this Surface to Exact Templets
NUT BUSHING-PHOSPHOR BRONZE. Make One
1¼" Drill
Tap ½" Hole for Oil Pipe
½" Nipple 5" long for Oil
⅜" Oil Hole
Allow ⅛" finish all over
Core 3⅝"
Key Way ¾" wide ⅛" deep in each piece 2" long
Allow ⅛" finish on Bosses
MAIN NUT BASE Make One-Cast Iron
Core 5½" dia.
Drill and Tap for ⅞" Tap Bolts
Allow ⅛" finish on each Half
Drill for ⅞" Tap Bolts
Allow ⅛" for finish
Cap-Make One-Cast Iron
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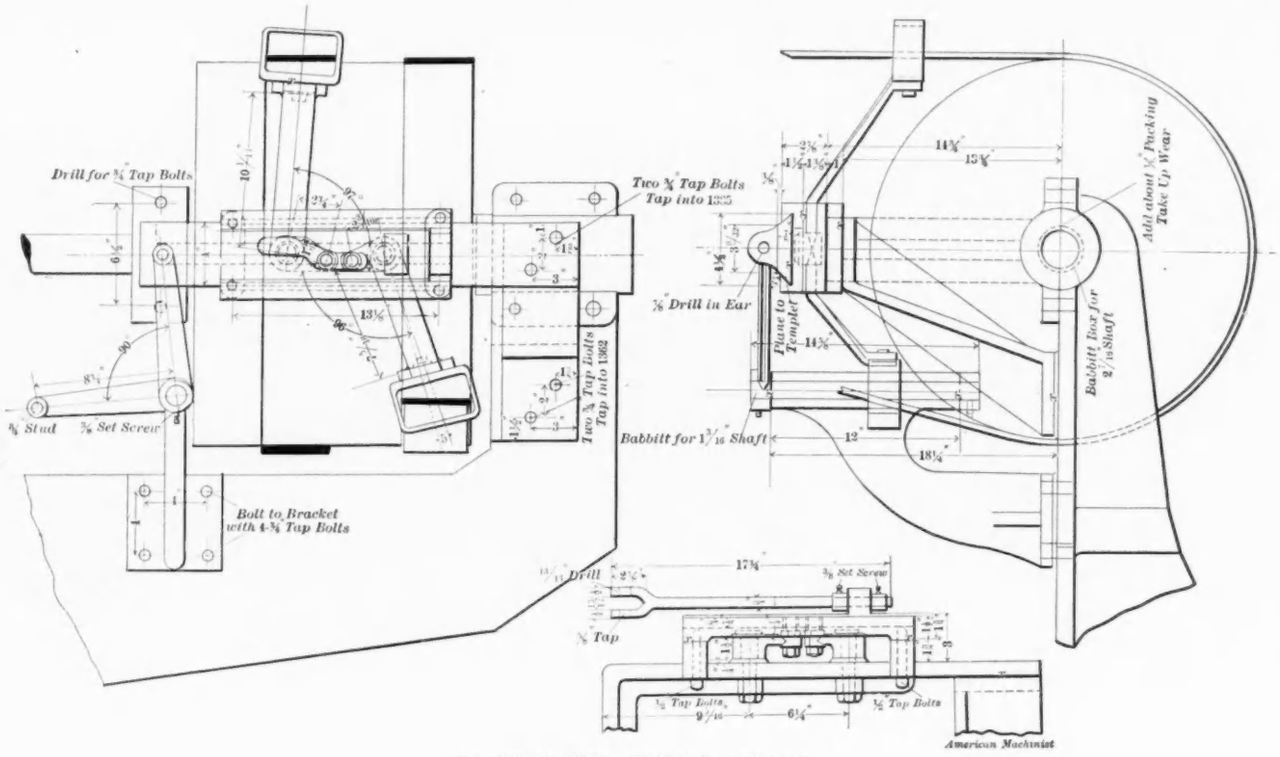
STONE PLANER—NUT FOR MAIN SCREW.


Drill for ¾ Tap Bolts
Two ¾ Tap Bolts Tap into 1355
Add about ¼ Packing Take Up Wear
⅞ Drill in Ear
Plane to Templet
Babbitt Box for 2 7/16 Shaft
Babbitt for 1 3/16 Shaft
⅜ Stud
⅜ Set Screw
Two ¾ Tap Bolts Tap into 1362
Bolt to Bracket with 4-¾ Tap Bolts
Drill
⅜ Set Screw
⅜ Tap
½ Tap Bolts
½ Tap Bolts
American Machinist

STONE PLANER—SHIPPER DETAILS.

Bicycle Tools—XXII.

HUB-MAKING PROCESSES.

The Lozier shops have adopted a mixed hub production method, embracing the use of two kinds of Hartford machines—the Hartford Screw Company's "Spencer" automatic and the Pratt & Whitney screw machine, both of which are built by Pratt & Whitney, the former by contract for the Hartford Screw Machine Company. Of these Spencer automatics the Hartford Screw Company have sold a vast number to the cycle shops, and have about a thousand of them in operation in their own factory in Hartford, Conn.

In adopting the Spencer automatics and the Pratt & Whitney hand turret machines, the Lozier followed thoroughly-tried practice, and their screw machine department at Thompsonville, about 25 miles northeast of Hartford, is in many respects better arranged for the production of cycle parts on these standard machines than any other I have seen. The shop is a new brick building, standing alone, excellently lighted, and contains nothing at all except screw machines and the appliances, in the way of shaving and polishing lathes, needed to finish the cycle parts produced on screw machines. This shop is the latest creation of its kind, and presents many novel features in its practice, both in tool-making and in process step grouping, or production methods. In fact, although this shop uses such thoroughly-tried and well-known screw machines that novelties in its practice could hardly be expected, it is still true that variations from commonly accepted methods of use are there to be seen on every hand, and without exception these novelties are in the line of both cheapening and bettering the output.

Perhaps the most notable of these innovations is to be found in the oil supply for the screw machines. Without exception, all screw-machine cuts in this shop are flooded with the best lard oil, no matter what the material operated upon may be. Too much emphasis cannot be placed on the great economy of using floods of lard oil on every machine cut. I have seen lathe work of enormous dimensions with flooded lard oil lubrication on an operation which under old machine-shop practice would have been executed with dry cutters, and was informed that the work could not be done at all without

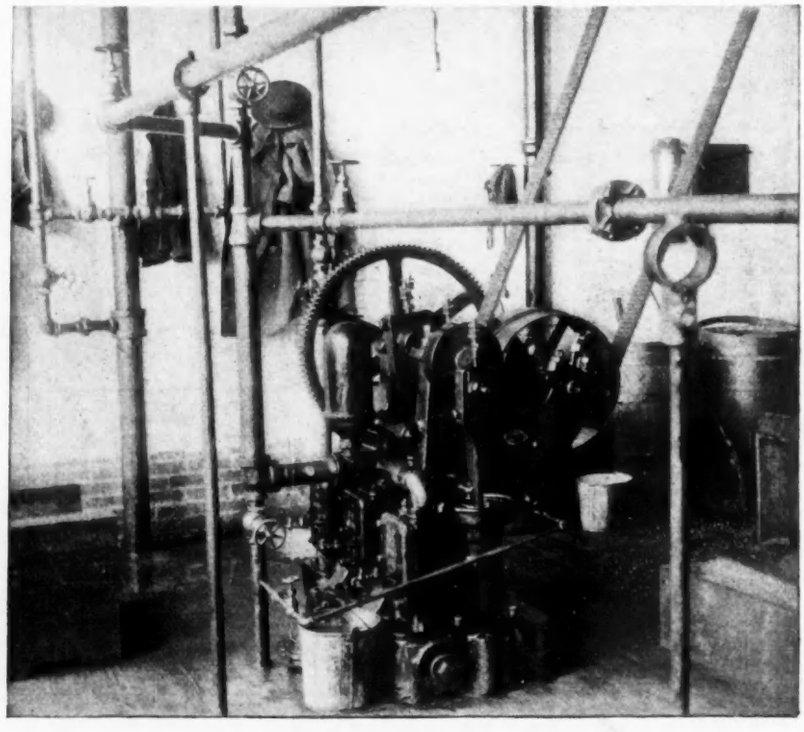


Fig. 139. OIL PUMPS FOR SCREW MACHINES.

the flooded lubrication. It is perfectly true that it is not yet the practice to flood lathe cuts on large work with lard oil, and flooded lubrication may never be the common practice on such work; it is practicable, however, and would in most cases, I believe, prove economical with proper oil-distributing devices.

But with small work and on screw machines there can be no question as to the propriety of using lard oil lubrication of such volume as to fully immerse the tool and chips and part of the work. This requires a great supply of oil, which has in all cases seen by me up to the Thompsonville Lozier plant, been had by the use of an individual oil pump, oil pipe, oil-catching pan, and reservoir for each screw machine, little or big, in use. Up to a very recent period the Thompsonville screw machines each used its own oil pump, and one man was constantly employed in the needful repairs on the oil work of this lot of screw machines. Again, there was often a loss of time directly due to the use of individual oil pumps. The oil would fall back in the delivery tube as soon as the machine was stopped, and would not begin to flow as soon as the machine was started; hence, to avoid a possible damage to expensive cutting tools, the machine was allowed to make a few idle revolutions to start the flow of oil before the cut was started. In some cases this made as much as ten per cent. difference in the output.

Mr. C. P. Ball, superintendent of the Lozier Thompsonville shops, replaced this old method of oil distribution with a system of his own devising, which involved the placing of a very substantially built 3-plunger vertical oil pump, by the Deane Steam Pump Company, shown in Fig. 139. This pump is piped to every machine in the place which uses flooded lubrication, and the oil pans of the machines are piped back to a settling tank, from which the oil pump takes its suction.

The one difficulty in the way of using a single source of oil supply for two or three hundred screw machines, lies in the possibility of a stoppage in the main oil delivery. To meet this objection, Mr. Ball has introduced a system of live steam piping by which the pumps and the oil delivery pipes can at any time be blown through from the machines towards the pumps. There is also a by-pass pipe and valves for the oil-delivery surplus, and the whole system is perfect in its working. I shall, if possible, give an extended description of this oil distribution, as it is of great importance. The "pump-fixer's" office is now vacant in the Thompsonville shops, and there are no more machines idle for want of oil, and there is no more delay because the oil does not start when the machine starts, nor is there trouble caused by an unwished-for stream of oil when running the machines in tool-setting, and so on.

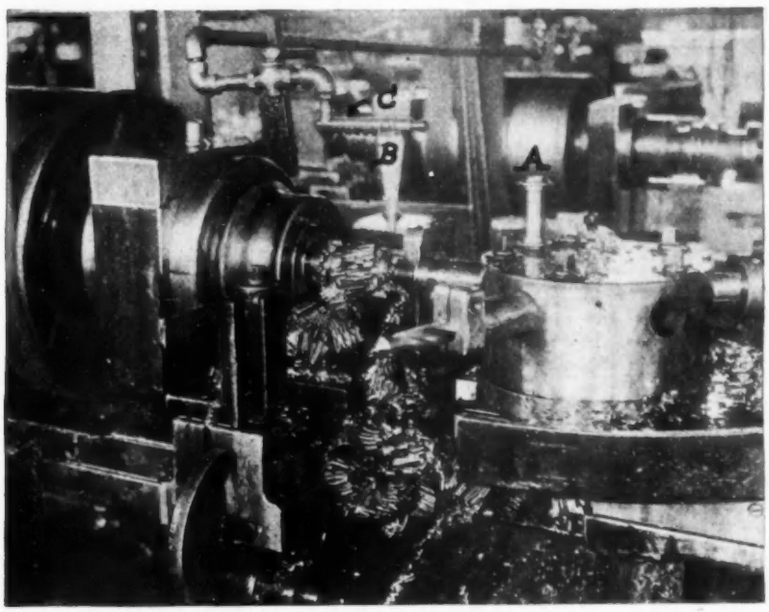


Fig. 140. A HUB CUT.

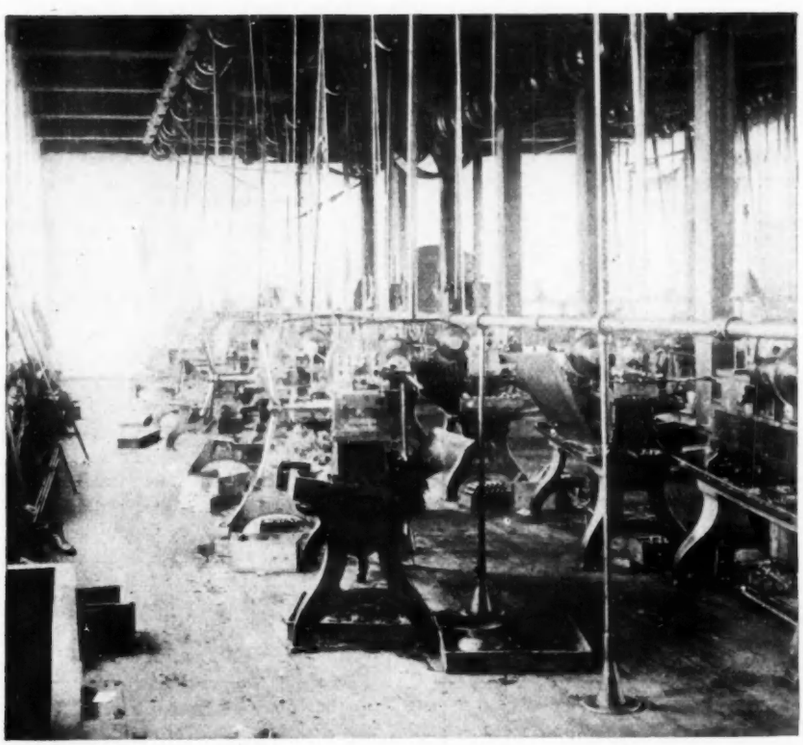


Fig. 141. PRATT & WHITNEY SCREW MACHINES WITH OIL PIPING.

Centrifugal machines are used to save the oil from the chips. A wide, thin chip, such as is shown in Fig. 140, carries away a vast quantity of oil; the chip is crinkled into a guttered and cupped surface, admirably adapted to hold oil. But the centrifugal machines save nearly all of it.

A, Fig. 140, shows the shape of hub in course of production, a finished hub being placed on the turret while the picture was taken. *B*, Fig. 140, is a special oil guide which collects the streams from three or four of the oil holes in the bottom of the oil pipe *C*, and delivers the combined flow at one point on the work.

In Fig. 141 the general oil-pipe system and the manner of its support are quite clearly shown. Fig. 141 also shows a double bank of Pratt & Whitney screw machines (which are called "hand machines" in shops using the full automatics), which are used to finish the hubs partly completed by the Spencer automatics. These first machines make the full outside cuts, giving the whole outside shape of the hub, bore the hole nearly through the middle, and make the cham-

ber at one end. The incomplete hub is then cut off.

A Spencer automatic is shown in Fig. 142. This is not the largest size of Spencer in use in these shops, but it is as stiff and strong as the largest, and is the size preferred by Mr. Ball for hub-making. The production of partly finished hubs, as shown standing on top of the turret slide of this machine, which was stopped in the midst of work for the picture, is about 50 per day of the large hub shown; and one hand attends five or six of the full automatic machines, which would make the wages of one man pay the labor on, say, 200 to 300 hubs in this form.

Fig. 143 shows a better view of a Hartford Screw Company's "Spencer" automatic screw machine than I could obtain at the Lozier shops. The machine is too well known to demand a detailed description here. The hubs are taken from the automatics to the hand Pratt & Whitney machine, Fig. 141 (from a picture taken in the noon hour), where they are placed in special fixtures and have their rear-end cuts made. This finishes the Lozier hub up to grinding, and the grinding is not done at the Thompsonville shops, but at the Toledo shops, on very interesting special hub-grinding machines.

The last operation on the hubs in the Thompsonville shops is to put each hub on an arbor, and spin it by hand on bench centers to test its truth. This work is done by women, who detect very small eccentricities in the work with great certainty.

HUGH DOLNAR.

▲ ▲ ▲

Tennessee will hold a Centennial Exposition at Nashville next year, beginning May 1st. Prof. Wm. T. Magruder is Chief of Machinery.

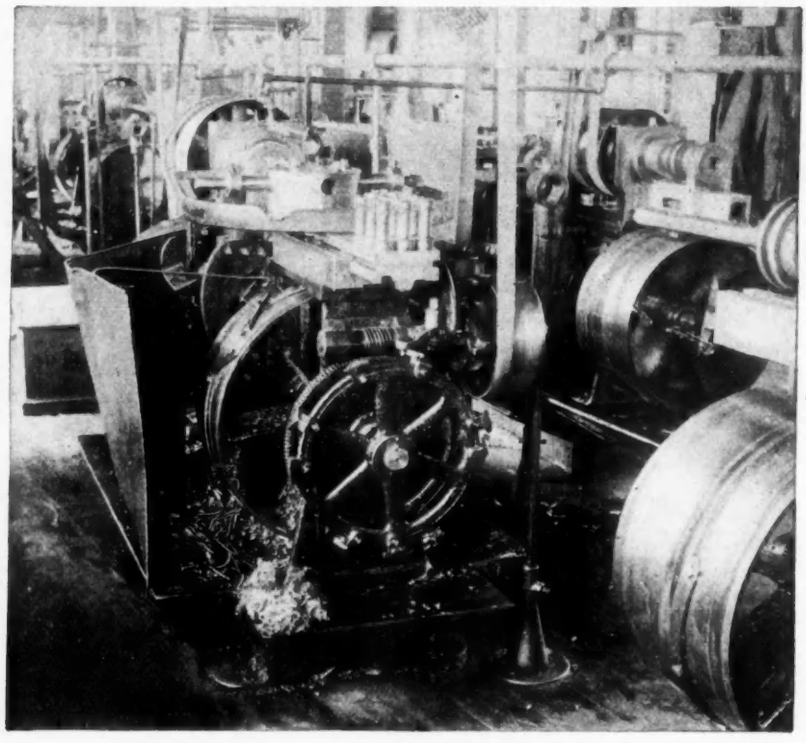


Fig 142 HARTFORD AUTOMATIC SCREW MACHINE.

Cooling Water for Condensing Purposes.

BY W. H. BOOTH.

In going about the country, I often come across cases where "they would employ condensing engines if they had sufficient water." This excuse is all very well in its way, but it has no foundation in fact; for by means of an atmospheric condenser, as little water is really consumed by the evaporation as is blown into the air by the engine when working non-condensing. But where there are condensers, and the water supply is limited and the area of the condensing pond is small, and therefore the water is used over again quickly and it is necessary to reduce its temperature, there are ways of doing this which are neither cumbrous nor costly.

Alongside the Great Eastern Railway, out of London, there is a works of some description at which a long slated roof is used for cooling purposes. A pipe is laid along the ridge of the roof and is pierced with a number of holes, out of which water spurts up an inch or two and flows in a thin layer down the sloping, slated roof, collecting in the rain trough at the eaves and presumably being then collected for re-use. A roof is really an excellent area for cooling water.

Alongside the Great Western line, about twelve miles out from Paddington, there is a cooler of another type. It stands about 30 feet high. On the top, extending the full length of the apparatus, which is nearly 150 feet long by 15 feet wide, there is a large wooden trough receiving the condenser discharges from the engines. It is pierced along both sides at intervals of about 9 inches, with holes in which are fixed short spouts. These spouts deliver the water from the large trough into a series of troughs, as in Fig. 1, which is a view of one end of the structure, and Fig. 2, which shows a part of the cross-section. The troughs are formed by nailing a narrow board on each side of the upper ends of a series of thin boards *a a a*. The

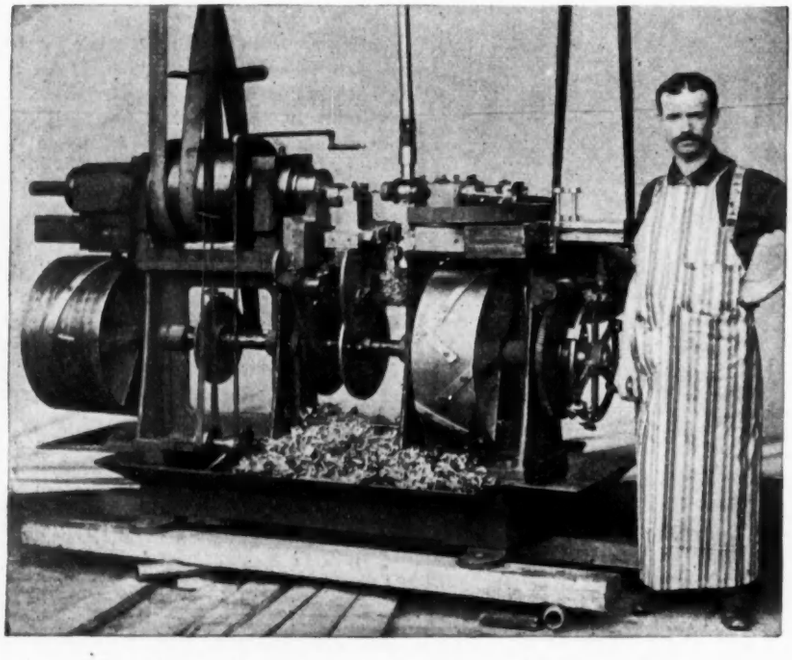


Fig. 143. HARTFORD AUTOMATIC SCREW MACHINE.

upper ends of these boards form the bottom of the trough. As seen in Fig. 2, the trough sides are notched out at every board, and the water flows out at the notches and down the rough surface of the sawn boards, which hang down about 10 or 12 feet. They are doubly pointed at their lower ends. These points collect the film of water which flows down the boards, and deliver it in two streams, as shown, to a second series of narrow troughs, formed exactly as above described, and down a second series of boards—the only difference being that the lower set of boards are placed transversely as regards the upper set, and it is thereby insured that, no matter which way the wind may blow, one or the other set will receive its full benefit, or both sets will each receive its partial effect. The boards are of ordinary, rough-sawn, inferior quality deals (pine) about 9 inches by ¾ inch. The distributing of the water is very well accomplished by means of the V-shaped notches and board ends. The water dripping off the lower boards has a free fall of about 4 feet through air. The whole arrangement is thoroughly open to the air, and exposes an enormous area of wetted surface to be acted upon by the air, the absorption by which of so much moisture has a powerful cooling action on what remains.

Such a structure is easily erected. It is simply a piece of rough carpentry; and in end view there are about nine boards in the upper set, seen on the flat, and, of course, double that number in the lower set, seen edgewise. In the side elevation of Fig. 1 the upper set has about nineteen boards in each section, while there are about nine in the lower set—a section, being that part of the structure between the main frames which carry the bearers to hold the sections. I do not show these supporting timbers, the sketch simply giving the general idea of the scheme, without showing the proportions, which, however, I have indicated in the description.

All the water to be cooled must, of course, be pumped up to the top of the apparatus; but this is not a heavy expense compared with the saving effected by the cooler water. Thus, let us suppose an engine is using 30 pounds of steam per horse-power per hour, and that by means of a condenser we save a fifth of this, or 6 pounds. This will represent a saving in coal of, say, 0.6 pound per horse-power per hour. The engine is now using 24 pounds of steam per hour, and the total weight of condensing water and of condensed steam will be probably 700 pounds, and this is lifted 30 feet. Expressed in foot-pounds, we get 21,000 per hour, or but little over the hundredth of a horse-power, which will therefore consume .025 pound of coal, or but 4 per cent. of the coal saved by condensation. The economy is obvious.

Evaporative condensers are coming gradually into use. These are simply built up of so many horizontal rows of pipe, over which water is spread in a thin film from distributing pipes. The steam is condensed inside the pipes at the expense of about an equal weight of water carried off by the air from the outside. No more water is lost by this than is recovered in the shape of steam condensed, and which would be lost if the engines had been non-condensing. Wherever there can be placed an evaporative condenser, the economy of condensation can therefore be secured, and there is no excuse of shortness of water to plead against their adoption, for in either case water disappears to about the value of the feed to the boilers. Given, therefore, water enough to make steam and there can be a condensing engine. Indeed, there is, I am told, a small economy of water to be thus secured.

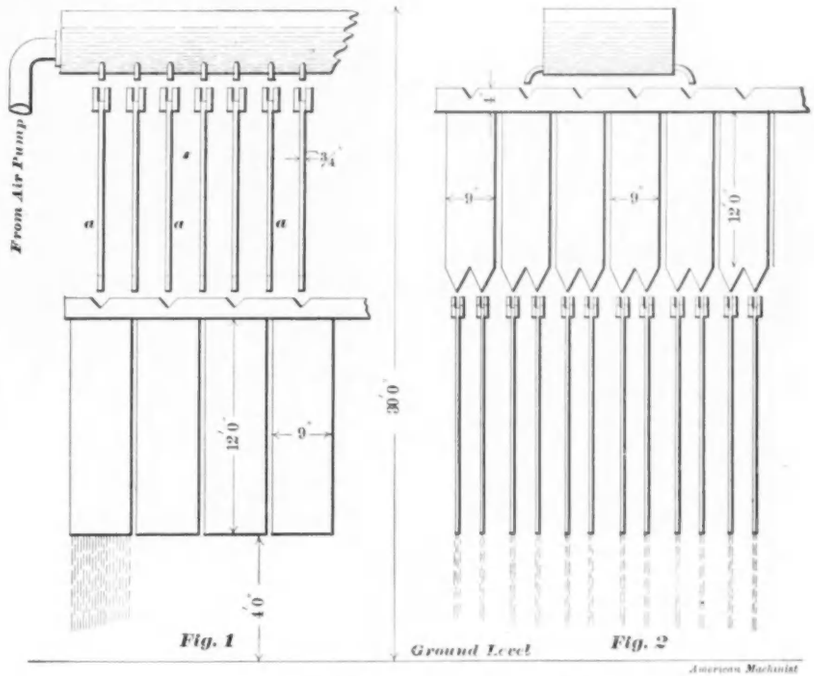


Fig. 1 Fig. 2

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A WATER-COOLING ARRANGEMENT.

In the apparatus sketched, the area of the wetted surface is increased about one hundred and thirty times the ground-plan area, and the efficiency must be considerably in excess of this ratio as compared with the surface of a pond of the area occupied. I am informed that where space is of still further moment, or where there is not free access of air, a tower filled with the same cellular structure has been tried, and air has been blown in at its base by means of a fan, with excellent cooling results. The apparatus I have sketched is in daily work, and proving very efficient as a cooler of large quantities of water.

London.

▲ ▲ ▲

For some reason there seems to be a desire not to have much said about American steel rails going to Japan, but considerable quantities of them are going there.

Table of Useful Factors.

BY ERNEST W. NAYLOR.

$$\frac{1}{\sqrt{2}} = 0.7071068$$

$$\pi\sqrt{2} = 4.4428829$$

$$\frac{\pi}{\sqrt{2}} = 2.2214415$$

$$\frac{\sqrt{2}}{\pi} = 0.4501582$$

$$\sqrt{\frac{\pi}{2}} = 1.2533141$$

$$\sqrt{\frac{2}{\pi}} = 0.7978846$$

$$\pi = 3.1415927$$

$$\text{Log. } \pi = 0.4971499$$

$$\text{Log.}_{\varepsilon} \pi = 1.1447299$$

$$\frac{1}{\pi} = 0.3183099$$

$$\frac{1}{\pi^2} = 0.1013212$$

$$\sqrt{\pi} = 1.7724538$$

$$\frac{1}{\sqrt{\pi}} = .5641896$$

$$\sqrt{2} = 1.4142136$$

$$\varepsilon = 2.7182818$$

$$\text{Log. } \varepsilon = .4342945$$

Modulus of common logarithms = .434294482

Log. of same = $\bar{1}.6377843$

$g = 32.19084$

[Mr. Naylor sends us some additional references giving Foote's constant, which we do not print. Appended to his letter is the above table of various useful factors. —Ed.]

An Adaptable Tool Holder.

We illustrate herewith a tool holder that seems to be capable of a rather unusual variety of adaptations. As will be seen further along, it is not merely a lathe tool holder, but is equally applicable to planer, boring mill, upright drill, or in other places where a cutting tool is required.

The essential part of this holder is the round hub or turret *A*, Fig. 1. This piece is of cylindrical shape, and pierced with two parallel slots for holding some common size of tool steel. These slots are far enough apart to clear the central bolt or screw which clamps the holder. The body *A* of the holder sets upon the collar *B* and is tongued into it enough to keep it central. The turret *A* has, besides the rectangular slot mentioned, two round holes at right angles to the other slots, and also intended for holding tools. The tops of the round holes are of the same height as the tops of the slots. The piece *A* is cut out at the top to a little distance below the tops of the slots, so that when tools are in the slots the upper piece *C* of the holder comes down upon them, and when the central bolt is tightened holds them securely.

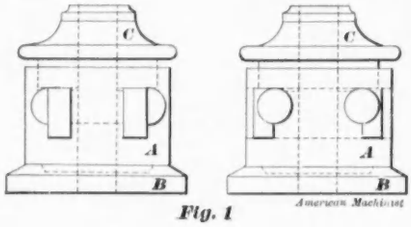

Fig. 1

APPLICATION OF TOOL HOLDER.

The collar *B* is used only in cases such as Fig. 2, where the holder takes the place of the regular tool post on a lathe carriage. On the same style of rest the stock, Fig. 3, may be used. This is a casting the shank of which is cored, and a round bearing is provided at one end upon which the bottom of the tool holder fits. The long shank is strapped on the top of the rest, and may be placed to project as far as, or in any direction, desired. Instead of coring the shank, it may be slotted for a center bolt, or more than one, as in Fig. 4.

Fig. 5 shows a stock using this holder for planer work. The tool is commonly held as shown by the holder at *A*. If it is necessary to have a projecting tool, as, for instance, in key-seating the hubs of wheels, extension pieces are sometimes used. This tool holder for planer work is interesting in another particular. It will be noticed that it is jointed at *c*, to allow the tool to lift up during the backing movement. It will be remembered that in our isue of February 6th we called attention incidentally to the fact that a tool, as ordinarily carried in a planer, has an objectionable tendency to spring down and dig in under the pressure of a heavy cut. We are told by the designer of this tool holder that he has frequently used

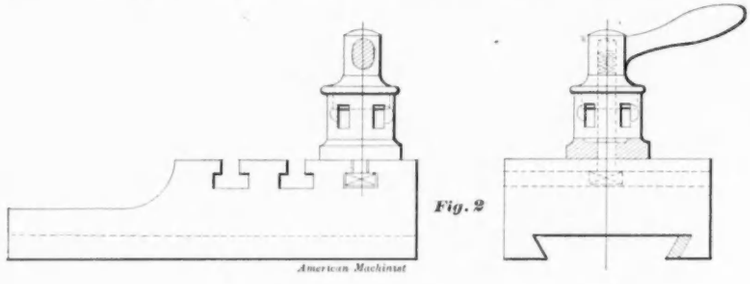

Fig. 2

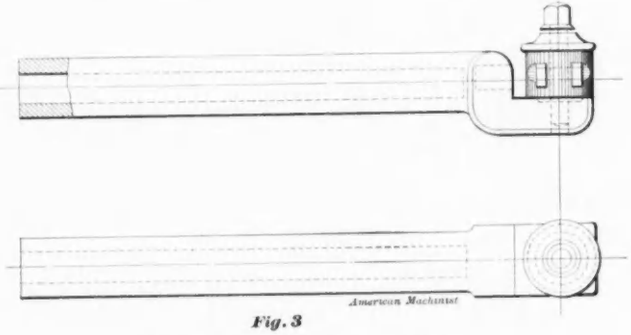

Fig. 3

AN ADAPTABLE TOOL HOLDER.

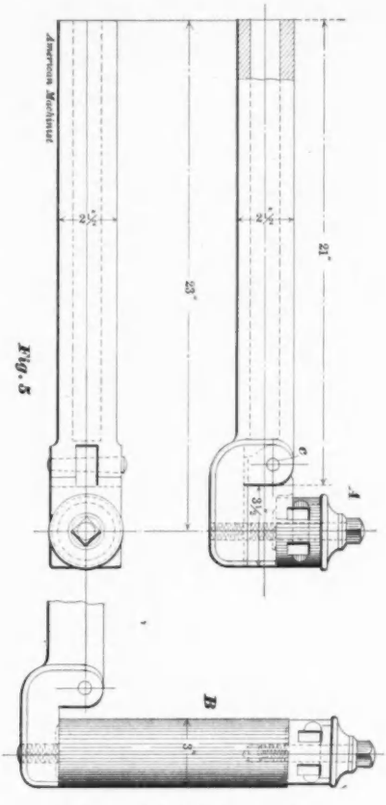

Fig. 5

TOOL HOLDER FOR PLANER.

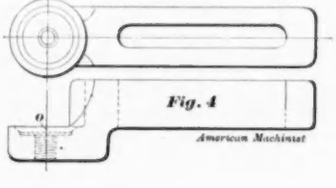

Fig. 4

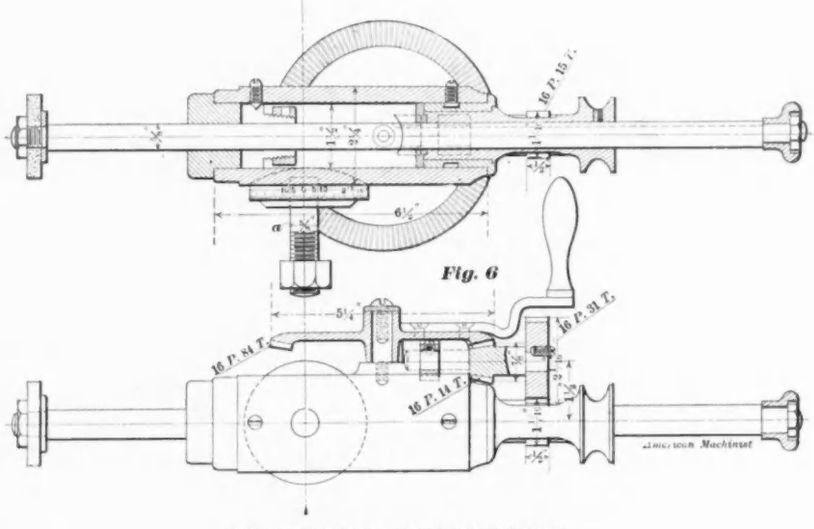

Fig. 6

GRINDING AND DRILLING DEVICE.

it in the planer backward, or so that it would do its cutting on the back stroke of the planer, fastening the holder down rigidly, and that it would do its cutting without a hint of chattering. Planing backward is not generally to be commended, but it would sometimes be a convenience and save shifting a job when necessary to plane up against a shoulder.

Where the stock, Fig. 4, is already provided, it affords a mounting for the grinding or drilling apparatus, Fig. 6. This is fastened by the center bolt *a*, and may be set at any angle required, for grinding centers, for grinding conical or cylindrical surfaces, external or internal, or for drilling. The spindle may be driven by a belt in the V-pulley, or by the crank and bevel gears. The spindle is pushed back and forth while running, by means of the knob on the right-hand end.

We have mentioned here only a few of the wide variety of uses of this tool holder as it is applied by the inventor in the shop where it was seen in use, that of Charles Ross & Sons, 18 Steuben street, Brooklyn. Mr. Wm. Lawson, foreman of the shop, is the inventor.

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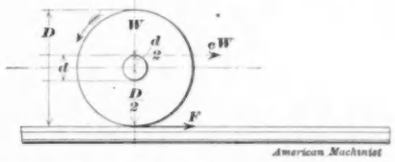
Power Calculation for a Traveling Crane.

BY CHAS. L. GRIFFIN.

The power calculations for effecting the several motions of a traveling crane involve the application of the simplest principles of mechanics. The following study of the subject is submitted in response to a request to outline the problem:

The power for traversing the entire crane under load—or, briefly, the bridge traverse—is, perhaps, the most difficult to figure, although the principles involved are clear. Speed having once become established, the chief resistance to motion is journal friction. The air resistance is inappreciable, and resistance due to irregularities in the track, or binding of the wheel flanges, should not be treated as calculable factors, for they are indications of inferior workmanship or design. Hence, since journal friction will be practically constant, we may consider that the problem is to find a constant force which will just overcome the frictional resistance, the consumption of power depending upon the rate with which we apply this force. If no sliding takes place between wheel and rail, every point of the circumference comes successively into contact with succeeding points of the rail. This condition is secured equally well whether the wheel rolls on the rail or the rail moves beneath the wheel, the adhesion being the same in each case. For convenience, suppose the latter. We then have the simple case of a wheel and axle in which the force at the circumference of the wheel—i. e., the force applied to move the rail—multiplied by its lever arm, the radius of the wheel, is equal to the sliding friction at the journal surface multiplied by its lever arm, the radius of the axle:



American Machinist

Let W = total load on all wheels;
c = co-efficient of journal friction;
cW = force of friction at journal surface;
F = force of traction;
D = diameter of wheel;
d = diameter of axle.

Then the algebraic statement of above is

$$\frac{FD}{2} = \frac{cWd}{2}.$$

$$\text{Hence, } F = \frac{cWd}{D}.$$

If we look at this formula carefully, we see that, if c and the ratio $\frac{d}{D}$ are constant, F varies directly as W; hence the number of wheels, or the distribution of the load upon them, has no effect upon the force of traction. This explains the use of W in formula above for the total load on all wheels; it is the simplest way, and equally correct. Theoretically, a car of given weight will roll as easily on a hundred wheels as on four. Practically, in such an extreme case, constructional inaccuracies would cut some figure; but with such a case we do not have to deal.

Having found the force with which we move the rail, and therefore the wheel, we must now make sure that with our given conditions of driving we have not exceeded the adhesive force of the rail to the wheel. This depends on two things—the total load upon driving wheels, and the co-efficient of friction between wheel and rail. The latter is a constant, and assumed to be 25 per cent. in case of locomotive drivers under usual conditions. In crane calculation, 20 per cent. is a safer figure. Having chosen the pair of driving wheels, and calculated the combined load which is carried on them, 20 per cent. of that figure will give the adhesive force. If this is greater than the tractive force, no slipping will occur. If the contrary, the wheels will slide on the rails; and we have the choice of eccentric loading to secure greater load on drivers, or an extension of driving gear to another pair of wheels, thereby decreasing the tractive force per wheel. The former method is apt to be the cheaper; but for heavy cranes, recourse must be had to the latter, else wheel loads become excessive.

It is assumed, then, that the tractive force F applied to move the rail will not slip the rail on the wheel. Hence, it merely remains to consider the rate at which we shall use this force in order to calculate power. The circumference of the wheel measured out upon the rail gives the distance the crane travels; hence, v feet of rail passing under the wheel, and actuated by force F, gives Fv foot-pounds of work done. If it takes one minute to travel v feet, since 33,000 foot-pounds per minute equals one H. P., the horse-power exerted is

$$H.P. = \frac{33000}{Fv}.$$

The torque in inch-pounds on the wheel axle will be

$$T = \frac{FD}{2}.$$

These figures being at the wheel, allowance should be made for efficiency of gearing to the prime mover, so that power in excess may be provided.

To illustrate by a practical example, let power be required for a crane 20 tons net capacity, weight of bridge and fittings (exclusive of bridge axles and wheels) 30,000 pounds, weight of trolley and bottom block 15,000 pounds, diameter of wheels 24 inches, diameter of axles 4 inches, speed of bridge, loaded, 300 feet per minute. Assume co-efficient of journal friction at 10 per cent. The total load, W of the formula, will be 40,000 + 30,000 + 15,000 = 85,000 pounds.

$$\text{Hence, } F = \frac{.10 \times 85{,}000 \times 4}{24} = 1{,}416 \text{ pounds.}$$

At 300 feet per minute, the power is

$$H.P. = \frac{1416 \times 300}{33000} = 12.8.$$

The torque on wheel axle is

$$T = \frac{1416 \times 24}{2} = 16{,}992 \text{ inch-pounds.}$$

It should be noted in the above how important a proper choice of the co-efficient of friction is with reference to the horse-power consumed. The figure 1,416, as based on 10 per cent. co-efficient, corresponds to about 33 pounds traction, or horizontal effort, per ton of total load. Sprague assumes 25 pounds per ton for street cars, which would seem to be a minimum figure. For well-fitted crane journals with ample lubrication, the co-efficient often runs as low as 8 per cent., reducing the horizontal effort to about 26 pounds per ton; but, on the other hand, imperfect track and bad alignment frequently give a figure as high as 12 per cent., so that the average value is as chosen above.

In all the preceding calculations the crane is supposed to have acquired the proper speed, and no account has been taken of the work necessary to start it from a state of rest and impart acceleration. Two assumptions must be made to calculate this—first, the co-efficient of starting friction; second, the kind of acceleration imparted, whether uniform or varied. The average power exerted to bring the speed up in a given interval of time will equal the sum of two quantities—the power to overcome friction, and the power of acceleration. Both can be figured, but both will be approximations of

the crudest sort. Hence the figures will not be followed here. As a matter of fact, it is found in practice that any motor which will stand its running load, without injury, will stand the extra effort which must be exerted for a few seconds in starting under the same load.

The method which has been followed at some length for the bridge traverse, of course, applies equally well to the trolley traverse with change of data. It may be well to note a point which pertains to both, viz., the maximum torque which can possibly be thrown upon the driving wheels under a given load. This is equal to the adhesive force on the drivers under the given load multiplied by the radius of the wheel. This torque can be exerted by reversing the crane under speed, thereby slipping the wheels, which is an indication that the adhesive force limit has been reached. The tractive force of a locomotive is always proportioned to be equal to the adhesive force of the drivers.

The calculation of power for effecting the hoist is a simple process, and to follow our illustrative example will be sufficient: Assuming the speed of hoist at 12 feet per minute, and that the total weight lifted is 40,000 pounds, with an additional 2,000 pounds for chain and bottom block, we have the horse-power of work performed as

$$H.\ P. = \frac{42000 \times 12}{33000} = 15.3.$$

If torque on the winding drum is required, the load per chain part multiplied by the number of chain parts acting on the drum surface multiplied by pitch radius of drum will give the required result. These figures, being net work at the bottom block, must be increased at the motor to provide for loss in transmission through the chains and gearing.

A study of hoisting-train efficiencies might well be made here, but space forbids. Suffice it to say that, of the work which the motor delivers to its end of the train, if 70 per cent appears as useful effect at the load, the efficiency is high and the conditions of working excellent. This figure is for a spur-geared train with a pair of winding drums, close-link chain winding in turned grooves being used. Wire rope would probably increase efficiency, but, from limiting conditions of construction, cannot be considered as standard for crane practice. Applying the percentage figure to our example, we have as power to be furnished by the motor at full load,

$$H.\ P. = \frac{15.3}{.70} = 21.90.$$

Springfield, Mass.

▲ ▲ ▲

An Unexplained Accident.

We have a newspaper account of a steam engine accident that is interesting and at the same time quite puzzling:

"The accident was caused by the piston head coming loose from the piston rod. Nearly everybody knows that the piston head is a flat disk of iron, fitted over the end of the piston rod. It moves back and forth in the cylinder and receives the pressure of the steam. The piston rod is attached to what is called the 'crank shaft', and this in turn is joined to the crank. The revolutions of the crank cause the fly-wheel to revolve.

"When the piston head became separated from the piston rod, it lodged somewhere in the cylinder. The engine was going at a high rate of speed, and the momentum carried the rod through one revolution. But as it was forced back into the cylinder it struck the head. Not being able to make the full stroke, something had to give. The cylinder head remained firm, or the piston might have been driven through it, but the crank yielded under the terrible strain. It is easy to get an idea of the force exerted, for the crank, which is of cast iron and 12 x 4½ inches, broke squarely off. Thus released, the piston rod drew out of the cylinder, and with the crank shaft and a piece of the crank, flew through the partition, breaking it down like straw and striking the brick wall of the boiler, several feet beyond, with a bang, making a deep indentation in the bricks.

"Engineer Humphrey was in the doorway, about to step into the engine room, when the piston rod and its attachments sailed by, close to him. It was a close shave, for if he had been struck he would undoubtedly have been killed.

"When the steam had cleared away and an examination could be made, it was found that, in addition to the damage mentioned, the head of the packing box had blown off and the cut-off valve had been broken."

The last paragraph, taken in connection with the rest of it, strikes us as peculiarly pathetic. The account, as a whole, is much clearer and more intelligible than we usually get from the non-technical reporter. It seems to be tolerably clear that the rod pulled out of the piston, that the crank broke, and that the piston rod and its connections flew around with considerable force and agility; but it is not so easy to understand the sequence of cause and effects. Did the piston pull off first, or did the crank break first? Taking the story as we have it, how did the piston rod get the force that it seemed to carry at the last?

Calling the end of the cylinder toward the crank the front end, suppose that the piston was just leaving the front end for its return stroke, when it pulled off the rod and was rushed to the back end of the cylinder by the force of the steam, and stopped there; and then, the shaft continuing to turn, the piston rod was carried backward in the cylinder, and, the end of it being unsupported, it struck the piston too low to enter the hole again, and so fetched up so suddenly that the crank was broken by the unexpected resistance. If the crank was turning over, instead of under, the connecting rod and end of crank would be thrown up instead of down, and would not drop at once. As soon as the center was passed, the piston would be thrown forward by the steam, propelling the piston rod and its trimmings; and when the end of the cylinder was reached, the piston would be stopped, while the piston rod could shoot out and play the mischief. That is one way.

Now, suppose that for some reason or other—as, for instance, water in the back end of the cylinder—the crank broke first when the piston was nearing the back end of the cylinder, then a little further turn of the shaft would admit the steam behind the piston, and it would be shot forward until it fetched up suddenly against the front head, while the momentum of the piston rod and its connected parts would give force enough to pull it out of the piston and waste its remaining energy in independent acrobatics. It would seem quite possible for the accident to have occurred in this way. Taken as a whole, the accident seems to have been a rather peculiar one.

▲ ▲ ▲

Measurement of the Circle.

"An Old Reader" writes, asking us to tell him "where the constant .7854 is derived from, and also other decimals, if it is not too much trouble."

Nothing is "too much trouble" if it only accomplishes something desirable. If no results come from it, then it is too much trouble. If we are merely saving others from trouble (and with many, work and trouble are synonymous) and encouraging them in laziness, then it is too much trouble. If we are pointing out the way to those who do not know it, or who do not know how to find it, then it is not too much trouble.

The question asked by our correspondent is a natural and proper one. The constant referred to is an indispensable one in all computations relating to the circle. Very many persons, like our correspondent, use it frequently and secure reliable results by its use, without ever understanding just how the thing works. The only way to understand it is to become familiar with geometry, or at least to get a speaking acquaintance with it, and if this is too much trouble, then one has little excuse for not knowing.

Geometry is peculiarly and especially the study for the mechanic. It reveals to him, at every step of his advance in it, precisely the things that he should know and that he has most occasion to use. Geometry pays for itself in its revelations to the student as he goes along, and one who cannot appreciate its lessons cannot be much of a mechanic at heart. It may be followed without the aid of an instructor more easily and safely than any other study. It also requires or assumes for the student less knowledge of other matters than other studies usually insist upon.

In measuring the circumference or the

area of a circle, it is assumed to be a polygon of an infinite number of sides, and we can get as near to absolute accuracy in our measurement as we can get near to infinity. As infinity cannot be reached, so the circle cannot be squared, or the relations of circle and square cannot be accurately stated in figures, but may be brought nearer than any quantity that can be mentioned. We cannot here go into the methods by which results are arrived at, but we can show the results attained and their gradual and near approach to absolute correctness.

Taking a circle with a radius 1, or whose diameter is 2, and describing two squares, one outside and the other inside the circle, both just touching it, the area of the outer square will be 4 and that of the inner square will be 2. Retaining constantly the same radius 1 for the circle, and substituting external and internal octagons for the squares, and then going on and successively substituting polygons with increasing numbers of sides, the areas of the inscribed and circumscribed polygons continually come nearer to each other, and the result is this:

Number of Sides.	Area Inscribed Polygons.	Area Circumscribed Polygons.
4	2.0000000	4.0000000
8	2.8284271	3.3137085
16	3.0614674	3.1825979
32	3.1214451	3.1517249
64	3.1365485	3.1441184
128	3.1403311	3.1422236
256	3.1412772	3.1417504
1,024	3.1415729	3.1416025
2,048	3.1415877	3.1415951
512	3.1415138	3.1416321
4,096	3.1415914	3.1415933
8,192	3.1415923	3.1415928
16,384	3.1415925	3.1415927
32,768	3.1415926	3.1415926

This thing has been carried along so far that strings of more than a hundred figures beyond the decimal point have been reached; but there is no practical use in going so far. As we go down the column we see that the areas of the inscribed and of the circumscribed polygons continually come nearer to each other, while we know that the area of the circle must be somewhere between them. In the last row of figures given the areas of the two polygons are identical, but this is because some of the figures to the right of each have been dropped, and there is really still a slight difference between them.

The factor as commonly used is 3.1416, and instead of writing this every time it occurs, it is customary to substitute for it the Greek letter π (Pi). This factor represents the ratio of the area of any circle to the square of its radius, and also the ratio of the circumference of a circle to its diameter. It is really most frequently used for obtaining the circumference from the diameter; and where the area of the circle is required, it is generally more convenient to square the diameter and multiply it by .7854, which is one-fourth of our other factor, 3.1416.

This factor is also equally applicable in measuring a ball or sphere. Squaring the diameter and multiplying by 3.1416 gives us the area of the surface of a sphere, and the cube of the diameter multiplied by .5236 gives the cubical contents of the sphere. This factor .5236, it will be noticed, is one-sixth of 3.1416.

Computations relating to the circle are to be made from different data, and it is well to bear in mind, or to have at hand, the various transpositions of which the formulæ are capable. These are given in very convenient form in Kent's "Engineer's Pocketbook."

Let D = diameter, C = circumference, R = radius, and A = area:

$$C = \pi D = 2 \pi R = \frac{4A}{D} = 2\sqrt{\pi A} = 3.545\sqrt{A}.$$

$$A = D^2 \times .7854 = \frac{CR}{2} = 4R^2 \times .7854 = \pi R^2 = \frac{1}{4}\pi D^2 = \frac{C^2}{4\pi} = .07958\,C^2 = \frac{CD}{4}.$$

$$D = \frac{C}{\pi} = 0.31831\ C = 2\sqrt{\frac{A}{\pi}} = 1.12838\sqrt{A}.$$

$$R = \frac{C}{2\pi} = 0.159155\ C = \sqrt{\frac{A}{\pi}} = 0.564189\sqrt{A}.$$

▲ ▲ ▲

Chain Driving for Engine Governors and Other Purposes.

In our issue of Dec. 28, 1895, we spoke of the element of uncertainty or of unsafety in the practice of driving steam engine governors by means of leather belts. In connection with this subject, and as a consequence of our treatment of it, we have received from Mr. Hans Ronald, of Manchester, England, a catalog of his "high speed block driving chains."

Mr. Ronald, by the way, seems to be something of an American mechanical missionary in England. His catalog, for instance, is of standard size, 6 x 9 inches, and distinctly calls attention to the fact that this is the standard of the American Society of Mechanical Engineers. We understand also that Mr. Ronald's shop is largely equipped with American tools, and that American methods are generally employed.

In some of the arrangements of his shop, however, the practice is all his own. Mr. Ronald has made a special study of the advantages of driving machinery by chains instead of belts, ropes, gears or other devices. He claims that the chain driver is, first, as we all know, a positive mode of driving, and that it combines the advantages of wheel gearing with the simplicity of belt driving. He cites some of the advantages and the special applicability of chain driving as follows:

1. A short belt is always a source of trouble and uncertainty, the more so when the speed is slow and the pulleys are small. Only small amounts of power may be thus transmitted.

2. A belt driven steam engine governor is only in name a speed controlling apparatus. A belt more or less tight, and in good condition, running on small pulleys, will give in itself a speed variation of 10 to 35 per cent.

3. On an electrical car 10 horse-power is to be transmitted from the high speed dynamo shaft to the car axle, 3½ feet apart. For the necessary speed reduction large spur gears or intermediate carriers are highly objectionable, and do not permit the requisite flexibility in the axles. The conditions closely resemble those of the bicycle, where nothing has answered as well as chain driving.

4. Say that 40 horse-power is to be transmitted to a shaft 8 feet above, and 18 inches out of the perpendicular. There is no room for large or wide drums. This is precisely a case for chain driving.

Mr. Ronald's main shop is 92 feet by 34 feet, and 74 feet high, five stories and basement, with the engine in the basement. The line shafts for every floor are all driven by chains, transmitting some 50 horse-power and driving 150 machines. The chain driving has been in operation here for five years without an interruption beyond an hour or two for tightening the chain and once or twice to take out a broken link. The chains are less noisy than bevel gears but not as silent as belts or ropes. The chains have lately been taken down and replaced by an improved style of chain which is working perfectly silent, if such a term is allowable in connection with any high speed machinery.

In the shop are 56 machines in daily use, with chain driving applied for one purpose or another, and every machine has thereby become more efficient. A positive drive for feed motions makes a machine more reliable, and increases its production sometimes from 25 to 75 per cent.

An instance is cited where six years ago in an electric light installation the need was felt for a more reliable governor. A chain was put in place of the double leather belt, and the result proved so satisfactory that the engine builder has now adopted the chain for all engines, and 350 sets have been applied by this one firm.

The general and very satisfactory use of the driving chain upon the bicycle has commended it to the respect of the mechanical world, and we may reasonably expect to see its use continually extending in connection with machinery in general.

The bicycle, it may be remarked, has certainly been a great quickener of the mechanic and the inventor, and, what in these days is of great practical importance, it has "made" a vast amount of work for a wide class of workers, and as one thing leads to another the total influence of it upon the age is enormous.

ELECTRICAL MACHINERY.

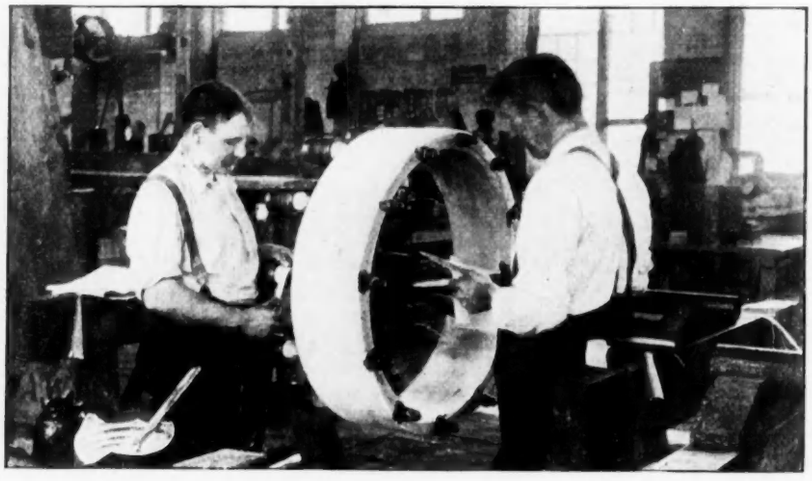


Fig. 10. INSULATING ARMATURE CORE.

The Building of a Great Dynamo—III.

The next step is "singeing" the core. The paper segments are cut about $\frac{5}{8}$ inch wider than the steel segments, so that they lap the segments about $\frac{5}{16}$ inch inside and outside, and totally conceal the steel when the ring is laid up, as is shown in Figs. 8 and 9. But it is desirable that the paper and the steel segments should exactly match up on the interior and exterior of the ring. It would be nearly or quite impossible to cut the iron and paper segments so exactly as to make them match perfectly when laid up. Consequently, the paper is cut too wide; and after the ring is all completely laid up and the armature bolt nuts are turned down hard, the surplus paper is singed off. This process is effected by mounting the star and core on a revolvable arbor in wooden boxes on high horses standing on each side of a very large charcoal brazier filled with burning charcoal, and turning the ring slowly until the overlapping edges of the paper segments are all perfectly burned away. I could not get a good picture of this operation. The same effect is gained in other shops by the use of plumber's gasoline "blow torches," in a much less picturesque manner, which is, however, fully as smoky as the Siemens-Halske method.

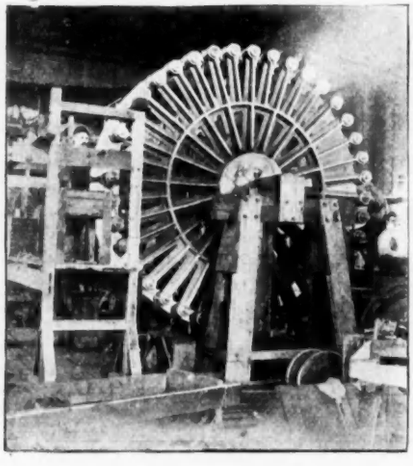


Fig. 11. INSULATING ARMATURE CORE.

Figs. 10 and 11 show, respectively, workmen in the course of insulating a small and large armature core. After singeing, the core is first painted with a coat of zinc white and is then wound all over with heavy linen tape $\frac{3}{4}$ inch wide, and is then covered with asbestos sheet $\frac{1}{32}$ inch thick all over, smoothly and evenly, the asbestos being cut with shears to fit, and applied by experienced workmen who make an extremely smooth neat job of this operation, as is clearly shown in Fig. 10, where the small armature core is shown almost completely covered with the white asbestos sheet. The star is mounted on an arbor in journals, so as to be easily revolved. The large armature in about the same stage of progress is shown in Fig. 11. After this elaborately laid-on covering of sheet asbestos, the whole surface is covered with seven or eight layers of mica in shellac, placed and fitted with great care; and again, outside of the mica a complete and carefully fitted covering of pasteboard is laid in thick shellac, and the whole is very carefully bound with tape while drying. After the shellac, varnish or cement is perfectly dry, the tape binding is unwound, and the armature core is then ready to receive the commutator bars, about 2,000 in number, which, with an equal number of U-bars soldered into the commutator bars, closely and entirely surround the entire armature

Fig. 12. FITTING INSIDE COMMUTATOR BARS.

Fig. 13 STRAIGHTENING OUTSIDE COMMUTATOR BARS.

core. These commutator bars are made of copper forged under great pressure, so as to make them as hard as possible.

The commutator bars and the U-pieces are made to the Siemens-Halske drawings at the Ansonia Brass & Copper Company's Works, and by the American Electrical Works. The copper must be so worked to be as dense and as hard as possible. The operations on the U-pieces and commutator bars are shown in Figs. 12, 13 and 14. The U-pieces take a vast amount of hand work because there are so many of them, and occupy a large department of the winding room. Fig. 12 shows the U-piece gang at work, straightening the bars with wooden mallets on cast-iron surface plates, and filing off any small roughnesses, and also filing the two ends of the U to gage, so they will slide freely in the "slate frame" joint slots sawed in the ends of the commutator bars. Fig. 13 shows the commutator bar gang at work —also with wooden mallets and surface plates, vises and files. The commutator bar is a single straight piece of flat copper bar, and has to be straightened and made smooth; stacks of commutator bars are seen piled on the floor back of the workmen. Fig. 14 shows the operation of shearing the ends of the U-pieces to gage, and a lot of U-pieces stacked on the floor in the foreground. Fig. 15 shows the finished U-pieces, bent in nests or groups to pass the armature core bolts, cut with four thin saw cuts in each end, and having their ends tinned ready to solder in the slots in the ends of the commutator bars.

H. L. A.

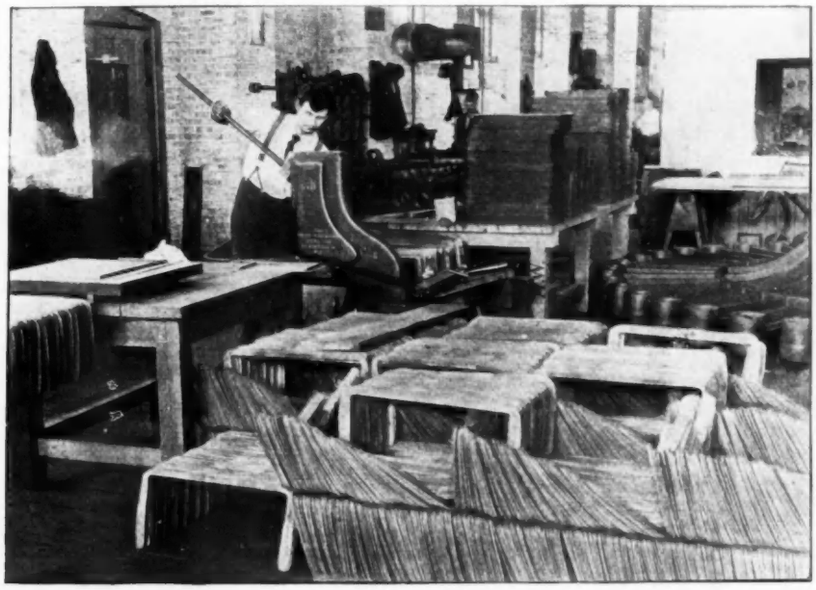


Fig. 14. INSIDE COMMUTATOR BARS—CLIPPING ENDS.

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LETTERS FROM PRACTICAL MEN.

Firing Dust Fuel..

Editor American Machinist:

There is being exploited at the present moment a system for the burning of coal which has been reduced to a condition of dust. Numerous coal-mine explosions seem to afford evidence that an atmosphere laden with coal dust is in a very explosive condition, fine dry coal dust being in this respect little different from gas. The explosions that sometimes occur in flouring mills go to prove the same thing. It is a well-acknowledged fact that a substance in a fine state of subdivision has, compared with its bulk, a large superficial area exposed to external influence, such as to the effect of oxidation. Dust fuel laid in a mass burns with difficulty; but when dispersed in air, with every minute particle in close contact with oxygen, its combustion is easy.

The system of firing dust fuel consists in allowing it to dribble into a current of air which carries it forward to a brick-lined furnace, where the combined coal and air ignite and burn with an intense flame like a blown gas furnace. Indeed, coal dust acts like gas. Every particle is separate and surrounded by air; and it is an easy matter to calculate just how much coal dust should be mixed with the air to secure combustion without excess of air, especially where precautions are taken to thoroughly distribute the coal throughout the air current. In the arrangement that I have seen, air is drawn into the furnace in the ordinary manner by means of a chimney draft through a large pipe, about twenty inches diameter, and fixed inside this pipe is a fan or turbine wheel like the fan of an anemometer. This fan is revolved by the air current, and its spindle is arranged with small projecting lugs, which serve to keep a small sieve in a constant state of vibration; this sieve forming part of the bottom of a coal-dust hopper, and the vibration insuring a continual dribble of dust into the air current, with which it is intimately incorporated before it enters the furnace, where it at once burns, being ignited by the heat of the brick lining and by the flames already there.

I have had no opportunity of inspecting the residue after combustion, and do not know if the combustion of the fuel is complete as regards the carbon, or whether there is much semi-coked dust remaining. In any coal is always a certain percentage of ash; and whether the coal be burned as dust or as lump, this ash must remain. Of course, it is only as very fine dust that it can be left; but still it will be there, and must be found either as an accumulation in the boiler flues, or it will be discharged at the chimney and deposited within a greater or lesser radius therefrom.

It has been suggested that a settling

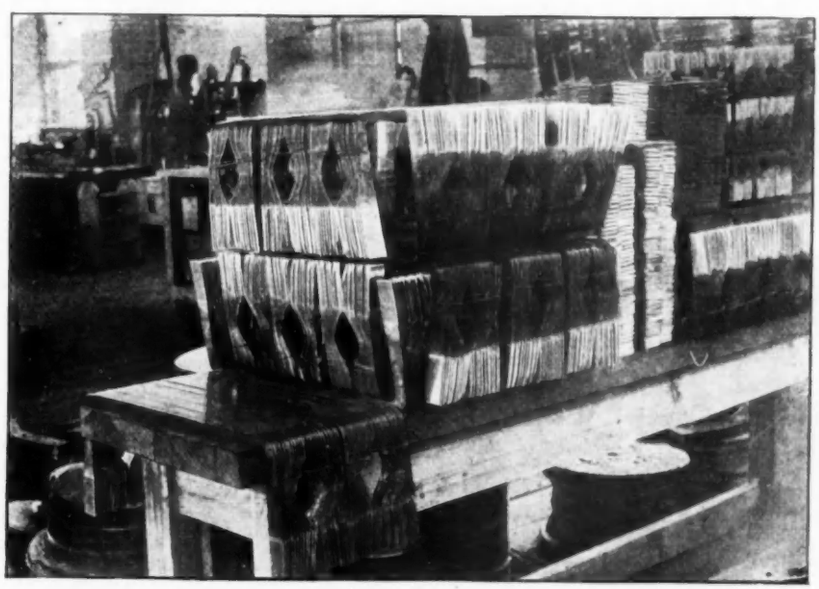

Fig. 15. COMMUTATOR BARS BENT TO PASS CORE BOLTS.

chamber or stive room should be provided, in which to allow the furnace gases to deposit their load of dust, and I have myself urged this in connection with dusty fuels and mechanical stokers; but I have had no wide experience of fuels all dust. Where dust fuel has been naturally obtainable—that is to say, it has been dust formed by handling friable coal, and not specially manufactured dust—I have seen it used in a sufficiently wet state to hang together when being fired, so that it would not follow the draft to the flues. But when thus used, coal dust cannot be burned at a higher rate than 10 or 12 pounds per square foot of grate per hour. When fired as dust, and thoroughly mingled with the air supply, there is no grate, of course, and the ideal furnace is obtained by means of the firebrick lining. But there must always remain the difficulty with the ash; and if the coal itself be ground to fine dust, how very much finer must be the residual ash! Anyone inclining to the use of dust fuel must be prepared therefore to provide suitable means of coping with this difficulty. It is a serious one, even with the ordinary proportions of dust in slack coals, when fired by means of sprinkling-type stoking machines, the dust being winnowed out by the draft; but when the fuel is all dust, and the draft is not even checked by a grate, and a bed of fuel on that grate, the results must be far more serious. The dust from a chimney is very efficient as a stopper of rain troughs, down spouts, etc., and becomes an intolerable nuisance to a neighborhood, as well as annoying to many manufacturing processes, if conducted in the open air.

London. W. H. BOOTH.

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The Function of the Key.

Editor American Machinist:

I was much interested in your treatment of the subject of keys and set screws, in February 27th issue.

There could be a good deal more said, I think, along this line, which would be of general interest to machinists, but it seems that those who are capable of doing this are inclined to regard the subject as beneath their notice.

Those who have had experience in overhauling machinery plants which have been in operation for any great length of time, have had unmistakable evidence, no doubt, that one of the weakest and most troublesome features of machine construction originates in poorly fitted keys and improperly fitted wheels.

Shafting in these days is, of course, all made to standard size, and in our shop all holes are bored to standard gages. Yet it is no uncommon thing to find wheels and pulley all the way from $\frac{1}{64}$ to $\frac{1}{32}$ of an inch larger than the shaft on which they should fit. When work is fitted in this way, it can hardly be wondered at that keys or set screws do not hold; for however tightly a key might be driven, such a hole would not be sufficiently elongated to give more than a slight bearing on the opposite side from the key, as shown at *o*, Fig. 2, thus allowing of a slight lateral movement, which is almost sure to lead to trouble. Fig. 1 shows a partial remedy for imperfect work of this kind, the bearings at *a a* serving quite as well as when the shaft fits closely.

Before set screws came into general use, those of us who date back to that period will know that, for keys, ranging up to ½ or ⅝ of an inch in width, a flatted seat on the shaft was all that was considered necessary—a fact which clearly shows that dependence must largely be placed on the friction which the key produces, and not on the driving power of the key alone. We have other examples of this, especially in the wood split pulley, which holds entirely by clamping. With split hubs in iron wheels and pulleys, the friction produced by the bolts is rarely depended upon, unaided by a key. I am disposed to think this the result of habit, and that wheels may be made to hold quite as well without a key, especially when the holding bolts have threads somewhat finer than the standard; as, for example, bolts 1 inch to 1½ inches may have threads from 12 to 14 to the inch, thus giving the bolt about the same drawing power as that of a key having a taper of ⅛ of an inch to the foot.

In keying up work that has been pressed, or shrunk, to its place, may not the practice of adding a key be questionable at times? In the absence of any data to sustain the belief, we can only surmise that keys are sometimes worse than useless in such cases, and that a good and uniform bearing around a shaft, which is of itself ample to withstand all the strains to which it is to be subjected, may be impaired by a tightly-driven key which has but a slight taper. For work of this kind, we believe a square key, with all sides parallel, and made to fit equally well all around, the best—providing, of course, that a key is needed.

In keying up ordinary slipping fits, I have always used tapered keys with parallel sides; and while there has been no special effort made to have the sides bear, yet it was a little more satisfactory when they did so, especially when conditions such as shown in Fig. 2 existed.

QUIRK.

[We trust and believe that our esteemed correspondent is incorrect in the assumption contained in his second paragraph. We find it impossible to accept it as a fact that those who are capable of speaking authoritatively upon this subject are inclined to think it beneath their notice. In our view there are few things of greater importance, mechanically, than this; and now that it is open, we hope that experience and judgment will have free expression.—Ed.]

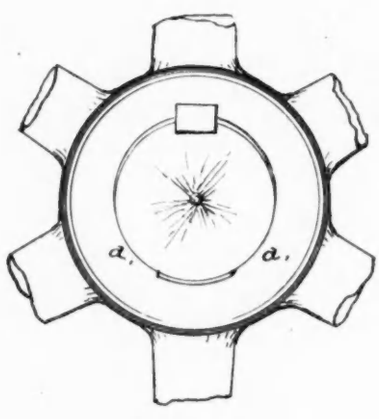

FIG. 1.

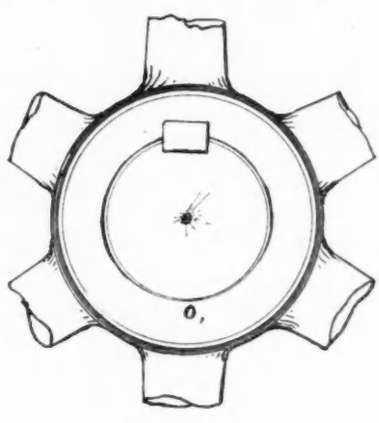

FIG. 2.

THE KEY WITH LOOSE FITS.

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Thread-Cutting Tools.

Editor American Machinist:

The square thread tool illustrated by Fig. 1 is familiar to all. This tool is the one mostly used in machine shops where the making of a large quantity of square-threaded screws does not belong to the routine of work, and when properly made it answers the purpose very well indeed. Square-threaded screws are cut, if a greater quantity of them is needed, more advantageously by a tool shown by Fig. 2. Of course, more time is required to make such a tool; but, considering the time lost and work spoiled by No. 1, it more than repays its additional cost, and the benefit derived from it is evident by a little consideration.

Before speaking of its value it is best to investigate its construction. It is necessary to determine the inclination of thread to be cut, and this can be done by drawing a line whose length equals the diameter of screw multiplied by π ($= 3.1416$), and at right angles to this line, at either extremity, draw a line whose length is equal to the longitudinal travel of thread in one turn. Fig. 3 shows the line $A\ B = \pi \times$ diameter; $B\ C =$

amount of travel of thread in one turn, or pitch (more correctly 1 divided by pitch); and the straight line *A C* indicates the inclination of thread which always should be the center line of the tool. The width of thread is left out of consideration entirely, as it may be made anything we please, or anything the particular case demands. The next step is to plane or mill off the lower surface, after which the shape is given to the tool by planing, giving equal clearance on both sides and making the top at right angles to the center line, which now will be inclined an amount equal to the inclination of *A C* to *A B*, Fig. 3.

This point of inclining the top of the tool I wish to emphasize particularly; its reason will be shown later. It is true such a tool will never cut a thread square, but will make the bottom rounded somewhat; but that will do no harm, because square threads are never made to fit top and bottom, while the ease of cutting can be imagined at once, for the tool will not only cut at the advancing side, but also at the following one, which also should cut up and down, but remove no material continuously.

What is true of chasing tools is also true of taps; that is, taps should have their grooves cut at right angles to their threads, which would make these grooves somewhat spiral (or helical), and the result would be less elbow-grease on the part of the man who uses them. This, however, is not done on any of them, and perhaps need not be done for smaller or medium sizes of all V or U. S. Standard threads, as the additional power required (by cutting parallel to center line) is infinitely small; but for very large and coarse threads, and especially all square-threaded taps, the grooves should be inclined. It would give a longer life to tool, produce more and better work, and last, but not least, give more comfort to the workman. Having gotten to taps which are only a different form of chasing tools, we may approach dies for which the above holds; but what I have in mind are dies to cut square threads with. These dies do not, however, at first sight seem to bear any relation to our ordinary ones used in die-

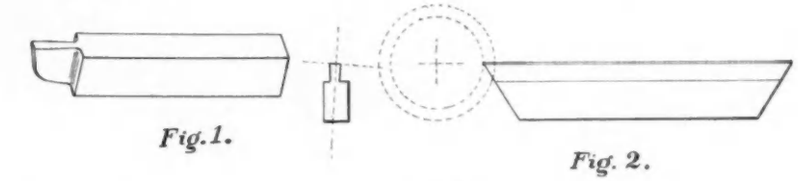

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 5.

Fig. 6.

THREAD-CUTTING TOOLS.

and not tear off the metal. Therefore, the threads produced by such tools are clean and smooth.

Besides cutting clean threads, it also has the advantage of being easily sharpened if an accident should occur, simply by grinding back. The greatest advantage, however, lies in the fact that this same tool can be used for cutting left-hand screws as well as right-hand ones, of the same pitch and diameter, simply by turning it end for end. These considerations are sufficient to show its value.

Fig. 5 shows a holder necessary for this kind of tool. In machine shops it is required to cut nuts as well as screws; and while the screw-cutting tool can be made comparatively stout, the chasing tool is always slender and springy. If, now, we should try to cut screws by a tool shown in Fig. 6, where the top is parallel, or in line, with the center line of nut or lathe, we will find it difficult to make any rapid progress, as the tool, by virtue of being too rank at the advance, will dig in, spring stocks, but are capable of being inserted in, or fastened to, a lathe; and all that can be done for a starter is to make a series of tools adjacent to each other—each succeeding one, step-like, longer than the preceding—and an equal number of similarly consecutive knives opposite to the first (it is not, strictly, opposite; but opposite, half pitch ahead or back), and make them capable of being brought nearer the work, and also to recede from it simultaneously, in the same manner a single tool is. This arrangement is probably, at first cost, the most expensive; but where there is a large amount of work to be done it will pay, and many screws are cut in this fashion for sizes ranging from 1 inch to 6 inches in diameter, and from 4 to 1, or even less, threads to the inch, and of lengths up to 10 feet or more. The saving may be supposed proportionate, or nearly so, to the number of tools used. Of course, it is to be understood that screws are not cut by these dies by passing over once.

E. LAWRENZ.

Brooklyn, N. Y.

Foote's Constant—Calculating Machines—Logarithms.

Editor American Machinist:

I have read with interest the article on "Logarithms—Foote's Constant for Diameter," in your issue of February 27th; but in regard to your editorial comment that you have never seen his method of obtaining the diameter from the circumference of a circle by the use of the reciprocal of π suggested in print, I would as that I have referred to only a few books accessible to me at the moment, but find it noted therein:

Molesworth's "Pocketbook of Engineering Formulae," in the editions of both 1880 (page 438) and of 1888 (page 632), under "Properties of the Circle," gives several uses for π; among them, the formula for determining the diameter from the circumference is expressed: Circumference $\times$ 0.31831 = diameter, which is the same as proposed by Mr. Foote.

Professor Unwin, in his very handy book on "Short Logarithmic and Other Tables," page 31, gives, under the values of π, $\frac{1}{\pi} = .31831$, to be used as the reciprocal of 3.1415926.

H. R. Kempe, in "Electrical Engineer's Pocketbook," page 4, gives: Diameter = circumference $\times$ .3183.

Nystrom, in edition probably of 1872, page 48, gives value of π to 45 decimals, and under values of π he gives $\frac{1}{\pi} =$ 0.318310.

From the above examples it would seem that no one at this day could claim the reciprocal of π as his special constant for diameters. In Kent's "Mechanical Engineer's Pocketbook" also, the multiples of one divided by π are given and each of these multiples in succession from 1 up to 9, for ready use in performing multiplication; the ratio of diameter to circumference equals the reciprocal of π, or .3183099, this reciprocal multiple being multiplied in succession by 1 up to 9 in the same manner, and a great many other useful combinations that express the gist of the whole subject as described by Mr. Foote. Kent always recommends the reciprocal in place of the whole number, presenting the whole matter in a very satisfactory form.

From the beginning of my own practice as a draftsman, I invariably wrote on the fly-leaf of whatever hand-book I was using the most, π and its reciproca multiplied by each of the numerals from 1 up to 9, so as to avoid the necessity of performing the multiplication, as the whole operation was reduced to addition either in long division or in multiplication.

The users of all good reckoning machines, such as Burkhardt's, for instance, employ the reciprocals of numbers and multiplication rather than the more

lengthy method of dividing by the number; for the reason that the reciprocal set up on the slides as the multiplicand can be used for a succession of multipliers, which multipliers show themselves at the respective holes or windows indicating the operation that has been performed, and a succession of multiplications can be performed without repeating the whole operation, change being required only in the figures shown in the windows of the last multiplier by adding to or subtracting from each figure what will change the existing multiplier into the one required. Thus, in tabular work, in such a case as 506, 507, 508, 509, each expressing a circumference of which the diameter is wanted, the multiplicand is set up as 0.31831, or more exactly, .31830989, so as to occupy all the eight columns. Eleven turns of the crank will give the answer to the first, 506; then converting the 6 into 7, 7 into 8, 8 into 9, in succession, the other answers required will be found with only fourteen turns of the handle in all. To perform the same calculation by division of the whole number by π, would, even on the machine, be quite a long operation, requiring the wiping out of answer and circumference and resetting for the next circumference.

I shall look with interest for the series of articles on the use of logarithms, but beg you will call attention to the limitations of logarithms, as shown in tabular work, where the whole numbers are large and involve decimals; for instance, in regard to diameter, circumference, area, side of equal squares, and so on, as usually given in the pocketbooks. I have had occasion lately to look over work done by logarithms, and find the tables are very satisfactory so long as small numbers are treated; but some of the tables we have been used to relying upon are wrong, and the errors have been repeated in successive editions after the publisher's attention has been called to the mistakes. In a table now before me, giving the diameter, circumference, area and side of equal squares for 93¾, the area is given as 6882.92, when it should be 6902.9135:

97½; Area given, 7474.20; should be 7466.19
90¼; " 6399.12; " 6397.12
80½; " 6573.56; " 6575.55

This table is correct up to 60 inches, but above that there are many errors.

The rapidity with which such tables can be made on the reckoning machine has induced many authors to use these machines in preference to logarithms. This I know to be the case with Professor Unwin in the preparation of his tables, for it was in his office in London that I first became convinced of the utility of the Burkhardt machine.

COLEMAN SELLERS.

▲ ▲ ▲

Ball Bearings.

Editor American Machinist:

Judging from the various sizes of balls used in the bearings of different makes of bicycles, one might be led to suppose that ball bearings knew no law.

Some three or four years ago very small balls were used in bicycle bearings, but they proved very unsatisfactory, for cones especially, and cups also, were soon destroyed and had to be renewed. The advance to larger balls seems slow. Some makers have adopted ⅜ inch for the crank shaft and rear hub, but I think they are rather the exception than the rule.

If I am rightly informed, tests have been made that prove, beyond doubt, that the carrying capacity of balls is as the squares of their diameters. In other words, one ½-inch ball will carry as heavy a load as four ¼ inch balls, and this would seem to be perfectly reasonable.

Those who advocate the use of small balls argue that, "as all balls bear on a point, and as more small balls can be placed in a bearing of a given size than large ones, there are more points of contact and the result a more durable bearing." The error in this argument is in assuming that a ball bears on a point, for it certainly does not.

If a ball is placed on a plane, it must be admitted that the surface immediately surrounding the spot of contact is removed an infinitesimally small distance from the surface on which the ball rests. It must further be admitted that the very slightest compression will cause the spot of contact to enlarge. If a larger ball is compressed to the same extent, the spot of contact will be greater than in the case of the smaller ball, because the larger the sphere the flatter the curve. As this increase is in all directions, it naturally follows that it will be "as the squares."

No doubt, many will assert that it is simply absurd to suppose that balls in a bicycle bearing are compressed to the very slightest degree, but that they do work under compression seems very simple to prove. If a steel ball is dropped on a steel slab, it will rebound again and again until it finally comes to rest. It certainly is a well-known law that compression must take place before a rebound can occur, and yet a very short fall will cause a slight rebound, which proves conclusively that very little force is necessary to cause some compression.

It must, therefore, be quite evident that, if durability is to be obtained in bicycle bearings, large balls must be used in the crank hanger and rear hub. A bearing that requires readjustment short of about two thousand miles, will soon become sufficiently worn to cause it to run far from easy.

ROLLER BEARINGS.

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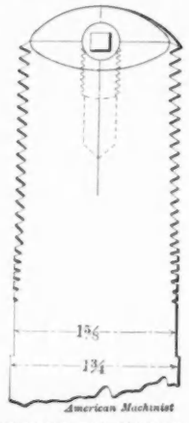
Holding Piston Rods in Crossheads.

Editor American Machinist:

Much has been said and written regarding the many methods that have been adopted for securing piston rods in crossheads. But the old easy way still survives, and I have recently seen a new engine that in other particulars was quite well designed, but with the jamb nut painfully in evidence for holding the rod in position. This is probably the easiest way the job can be done; besides, it leaves a little leeway for adjustment. But why is adjustment necessary in the length of a piston rod? It seems to me that there can be but one correct length, and that it is easy enough to find out what that length is and then make the rod just right. It isn't necessary for me to repeat that the jamb nut puts a strain on to the very



TIGHTENING BY TAPER PLUG.

weakest part of the rod, and that half of the work is intermittent, in addition to and in aggravation of that strain.

Having recently to design and construct a rod and crosshead, I found myself beset with the temptation to use the old and familiar jamb nut; but believing that the old custom would be more honored in the breach than in the observance, I finally adopted the method herewith illustrated. As will be seen, the end of the rod is drilled and tapped; in this case a ¾-inch pipe tap was used, as I found the taper to be about what was needed to give the required "grip." A steel taper plug, with square hole for driving, was fitted so as to very solidly press out the segment-shaped ends of the rod when screwed in flush. As will be seen, the end of the rod was sawed down in quarters for about 1½ inches, giving each part the same pressure from the taper plug. In this way we have the full strength of the rod at the shoulder, and the pull is distributed through the whole length of the rod that is threaded. Of course, the crosshead was bored to match the gradually run-out thread on the rod. In this case the rod was for a power pump; and, although subjected to severe duty, it is as firm in place as if cast there.

PETER H. BULLOCK.

▲ ▲ ▲

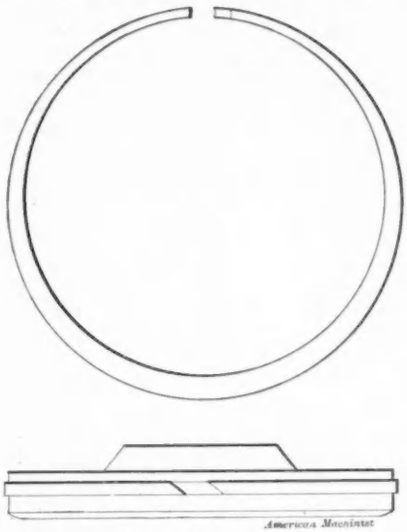
The Piston Valve.

Editor American Machinist:

When Mr. Booth writes on any topic he treats it intelligently. His recent discussion of piston valves brought up a subject which should have an interest for all builders and users of steam engines embodying such valve construction. The

piston valve (and this type should include all valves balanced against current and pressure of steam) has been very popular since the introduction of the "single-valve cut-off" engine. One might say the piston valve has made this engine possible. Its perfect freedom of movement makes it amenable to the slightest change of force exerted by governor weights, and insures very close regulation. The tendency to higher steam pressure will serve to make this form of valve still more popular.

The form of piston valve generally used in this country is that of a plug, without packing rings, running over unbridged ports. The workmanship in



PISTON RING OF WESTINGHOUSE AIR PUMP.

fitting these valves is so close that they are always tight when new. In fact, so far as wear from contact friction is concerned, they remain tight for years; it is not unusual to find a piston which has been running years to stand the shaking test for tightness admirably. But if one will take a valve after a few years' service and examine its edges and the chest ports carefully, he will find there has been a gradual wearing away of these angles by the very high steam velocity, much as water wears a rock, and the original tightness of the valve is gone. It is the lap edges of the valve and ports which determine their tightness, and the tendency of these points to wear under the wire-drawing of steam makes the plug piston undesirable unless frequently renewed with new valve and lining. Many of our builders have learned this from experience, and now anticipate such renewals in their original construction. The cost of renewals is not great, but the danger lies in neglecting them too long. When a leak is so gradual in its encroachment on economy, it is exceedingly difficult to say just when repairs should be made.

Piston valves with packing rings are not uncommon. One would say that a cylindrical valve may be packed so that it will be as tight as an engine's piston; and it might if there were the same force to drive it, and if all the conditions were the same. In packing piston valves for use in the single-valve automatic engine, care must be taken that too much load is not put on the governor; hence the difficulty in making valves which will remain tight and still permit the fine regulation called for. Expansion rings may be used if the ports are frequently bridged; but if they are broad, there will be a tendency to collapse under steam pressure before the port is opened, thus introducing a greater leakage than would come from the worn edges of the plug valve and ports. The problem of making a piston valve, at reasonable cost, which will remain tight, would seem difficult if it had not already been done.

When George Westinghouse, Jr., invented his compressed air brake for railway trains, he produced the first known direct-acting air pump, which in itself is a marvel of ingenuity and thought, as a part of his system. If one will study the admirable details of the construction of this pump he will find much to interest him, and he will also find the essential features of all direct-acting pumps made since; and he will find the solution to the problem of making an easy-working, tight piston valve. Mr. Westinghouse did this by using a narrow ring, turned enough larger than the bore to insure tightness without too much friction, thus confining the wear to the ring itself. The ring is cheaply made and easily put in valve, making repairs, when necessary, very inexpensive. Its narrow surface insures it against collapse under steam pressure, and its elasticity is such that it readily responds to inequality of surface. Its wear on port bridges is extremely slight and counts for nothing. The triple valves in the Westinghouse air-brake system are packed with this type of ring. If there were any appreciable leakage, it would be impossible to supply a freight train of fifty cars with the pumps now used. The accompanying sketch was made from a ring taken from an old triple valve.

Since the introduction of the Westinghouse engine, this form of ring has been used in valve and piston with excellent results. This engine is single-acting, with open cylinder and steam chest directly over the crank case; and any leakage, however small, would seriously interfere with the lubricant in the crank case. The low cost of lubricating this engine is a guarantee of tightness of valves and pistons. This form of ring packing is the cheapest, and I believe it to be one of the best.

New York. HARRIS TABOR.

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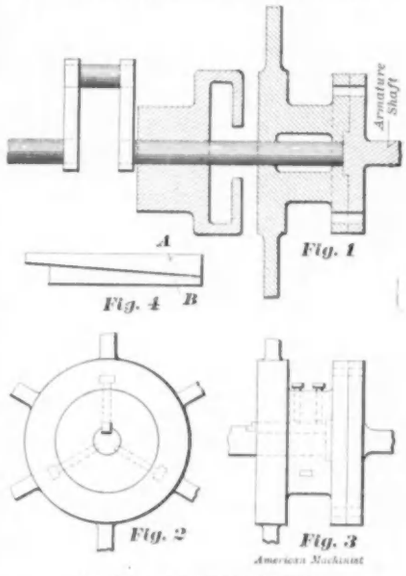
Fastening Fly-Wheels.

Editor American Machinist:

I can sympathize with Mr. Crane (February 27th), as I have been there myself.

Opinion seems to be divided about the function of a key; but, personally, I think that a sunk key should act by its resistance to shearing, and not merely as a wedge. Of course, this is on the assumption that the wheel fits the shaft, as it ought to. I always make keys to fit at the sides, and only let them touch at the top and bottom for the sake of keeping them in place.

A few months ago I was troubled with a fly-wheel on an electric light engine which it was impossible to keep tight. The wheel, which also acts as a coupling, weighs about 7 cwt., is 42 inches diameter and runs at 430 revolutions a minute. It



FASTENING FLY-WHEELS.

was supposed to be held in place by two pointed set screws and a key (Figs. 2 and 3), two additional set screws being fitted to keep the key in place. It was impossible to drive the key out with a drift in the ordinary manner, as the hub of the wheel comes to within about 1 inch of the cast-iron oil catcher on the bearing, Fig. 1; and as there was no room for a head on the other end of the key, the maker left it so slack that it could be pushed out with the finger—a highly original, but not entirely satisfactory method of overcoming the difficulty.

When the engine had been running for some time, the two set screws sheared off; and as the key fitted like a cow in a ten-acre field, the noise and vibration made it impossible to use the engine, it having two cranks at 180 degrees and steam on only one side of the pistons.

It was impossible to draw the wheel off, as the screws had broken diagonally, leaving a piece in the wheel. On starting to drill them out, it was found they were too hard for a drill to touch; so we softened them by connecting the shaft to one pole of another dynamo, the other pole being connected to an ordinary arc lamp carbon which was held against the set screw. Ten amperes soon did the job, and

when the screws were cool we started to drill again. When we had drilled part of the way in, the screws lost their hold on the hub, and, turning round, rendered further drilling impossible; but they were reduced enough to allow of the wheel being forced off.

Luckily, the wheel fitted the shaft; so a key was made in two parts (Fig. 4), the keyway being cut a little longer on one side than on the other. The part *A* butts against end of keyway and cannot move to the left; the part *B* is driven in as far as it will go and cannot move towards the right, as it butts against the armature shaft. *B* also projects to the left beyond *A*, and a slight tap on a wedge inserted between *A* and the oil catcher will start the key.

The two set screws were left in on top of the key to help keep it in place, the other two being discarded. The key is hardened and fits at the sides only, and the wheel runs a real treat.

H. PHILLIPS.

London, England.

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The Duration of Oil-Engine Explosions.

Editor American Machinist:

In Lieutenant Rodman's highly instructive and suggestive article upon "The Explosion in the Oil Engine," in your issue of March 19th, he says: "I cannot agree with Mr. Swift when he says, 'the slower combustion being when there was less to burn, instead of, as might be expected, when the amount of combustible was greater.'" It seems to be proper to say that I am not in the least responsible in this case. I merely called attention to what the indicator card evidently showed, that whereas the heavier charge of oil occupied 41 degrees of the shaft revolution for its complete combustion or explosion, the lighter charge of oil occupied 63 degrees of the revolution. It would seem that in the case referred to all the conditions were as nearly identical as possible, except the quantity of oil used for each explosion.

TECUMSEH SWIFT.

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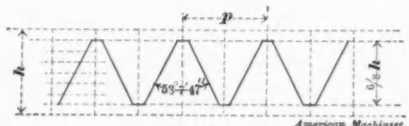
Metric Standard Threads.

Editor American Machinist:

In issue of February 20th of your valuable paper, you publish an article on Metric Screw Threads, in the course of which you allude to the standard adopted by the French Navy, which standard is said to have the advantage of closely conforming to our own standard. Now, while I do not want to advocate any improvements on the Sellers system, or any changes at all in screw threads, so long as our present system of measurement prevails, when it comes to adopting the metric system it would be folly to adopt a system of screw threads which has all the faults (?) of the Sellers system. I have always held the opinion that the angle of the Sellers system could be reduced with advantage. Other things being equal, a thread with a smaller angle has more bearing surface. A smaller angle also has the advantage of producing less friction. Witworth certainly had some reasons for making his angle 55°.

Some years ago I obtained from a German manufacturer of machine tools a catalog which contains a description of the metric system of screw threads adopted by the Verein Deutscher Ingeniere in 1892. In this system the angle is 53° 7′ 47″. (Don't laugh.) This angle is very easily



$h = p$

FORM OF METRIC THREAD ADOPTED BY GERMAN ENGINEERS.

obtained. Draw a triangle with two sides equal, and the third side, being the base, equal to the altitude; the angle opposite the base is the angle sought. Mathematically speaking, $tan\left(\frac{53^\circ\ 7'\ 47''}{2}\right) = tan\ 26^\circ\ 33'\ 53.5'' = .50000$. In this system the pitch is measured in the same way as in the French system referred to. The

TABLE OF METRIC THREADS.

Diameter of Screw.	Pitch.	Diameter of Screw.	Pitch.
mm.	mm.	mm.	mm.
1.	0.25	10.	1.4
1.2	0.25	12.	1.6
1.4	0.3	14.	1.8
1.7	0.35	16.	2.
2.	0.4	18.	2.2
2.3	0.4	20.	2.4
2.6	0.45	22.	2.8
3.	0.5	24.	2.8
3.5	0.6	26.	3.2
4.	0.7	28.	3.2
4.5	0.75	30.	3.6
5.	0.8	32.	3.6
5.5	0.9	36.	4.
6.	1.	40.	4.4
7.	1.1		
8.	1.2		
9.	1.3		

thread is flattened by taking off ⅛ at top and bottom, same as the Sellers thread. The root diameter of a screw is found by subtracting 1½ pitch from outside diameter, or $d = D - 1.5\ p$. This formula is so simple that, with this system, tables of sizes of tap drills are superfluous. I give herewith a table of pitches and a diagram of the thread as it is given in the catalog mentioned above. The pitch is the distance between two adjoining threads, without regard to the number of threads in one centimeter. Considering the many good features of the system, I think it well worthy of publication in the "American Machinist."

Milwaukee, Wis. R. G.

Storing Tracings.

Editor American Machinist:

If Mr. Carman, in the closing paragraph of his communication in your issue of March 19th, has not so effectively muffled my gun as to render its report uninteresting, I will touch off the following in reply:

It did not occur to me in making my proposition to compare the relative capacities of tube and flat storage of tracings, that the length of the sheet is a factor that must be identical in the two systems in order to make a fair comparison. My discovery of that fact was contemporaneous with the discovery that the figures Mr. Carman submits would make it appear that I have been "bluffing." Inasmuch as I do not know the Gates Iron Works size sheet, I have made a few experiments with our size, 22 x 36 inches, in some tubes which I happened to have, which measure 1¾ inches diameter inside and about 1⅞ inches outside. I found by rolling them tightly, that one of these tubes would hold twelve tracings. Rolled less tightly (to what I should call a "comfortable capacity"), I put not over ten tracings in a tube. The cloth of the tracings used is about $\frac{3}{1000}$ inch thick. Our storage vault contains two sections of shelves, each covering a wall space 6½ x 10 feet, or 130 square feet in all. Dividing the rack to hold the tubes into spaces about 2 feet long by 1 foot high, and making it of stuff ¾ inch thick, I should get into this space 4,536 tubes, or comfortably 45,360, and ultimately 54,432 tracings; comfortably about 350 per square foot of wall space.

The same vault space contains 156 shelf spaces, into which I slide portfolios or covers made from XXX manilla paper, folded once and open on three sides, the folded side toward the front of the shelf. In making a test of the capacity, I put fifty tracings in a cover, and one of the shelf spaces holds comfortably eight such covers, ultimately ten. This gives me storage capacity for, comfortably, 62,400, ultimately 78,000 tracings, or comfortably 480 per square foot of wall surface. When these shelves were put in I felt very heavy and strong, and the shelf stock was made ¾-inch thick. Half that would have been ample, and I intend now to replace the ¾-inch wood shelves with sheet iron some time, and thereby increase the number of shelf spaces to about 200, the comfortable capacity to 80,000 and the ultimate capacity to 100,000 tracings, or comfortably about 615 per square foot of wall surface. Building a tube rack on the "sheet-iron" plan, or more accurately of wire rods, the same space could be made to hold about 5,500 tubes, comfortably 55,000 and ultimately 66,000 tracings, or comfortably about 425 per square foot of wall surface.

The storage shelves are protected from dirt and dust by swinging covers of wood hinged to every third shelf, so that very little dust accumulates on the portfolios,

which afford absolute protection against dust to the drawings within.

I ought perhaps to say that I have figured on storing exclusively tracings for the purpose of making the comparison with tube storage only. So small a part of our drawings are tracings that tube storage here would be out of the question, even if I were a less confirmed heretic on the "rolled" plan. I did not expect that any confirmed adherents of either plan would be converted to the other by this correspondence, nor did I think that all your readers who might be contemplating the establishment of storage vaults would be led by Mr. Randol's enthusiastic description to rush to the tube-maker. There is merit on both sides of the shield. There are pleasures a-wheel between Worcester and Fitchburg that would not be met on the Jefferson Boulevard, and, per contra, the Boulevard is one of the things that will induce me to take the bicycle along and accept Mr. Carman's tempting invitation when I go next to Chicago.

WM. L. CHASE.

Worcester, Mass.

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Continuous versus Multiple Rope-Driving.

Editor American Machinist:

I would like to ask Mr. Booth a few questions which his article on Rope-Driving, in your issue of March 12th has suggested to me:

How many ropes of a set, on an average, will "bed" themselves into the grooves?

Does not this bedding (flattening the sides of the rope as it does) cause a differential speed effect on the flat side of the rope, if the driver and driven pulleys are of different diameters?

Can Mr. Booth give me his results which show that a rope which beds itself into a groove will last longer than one which brings different parts of its circumference subject to wear?

Why does he consider it important to have pulleys exactly opposite?

I have been led to think that the needlessness of exact alignment is one of the best points of rope-driving and I have noticed that some ropes of a set will bed themselves while others will not, which would prove that the question of alignment had nothing whatever to do with it.

Is it not better to stop once and splice a rope of the continuous system, than to stop eight or ten times and take off single ropes?

The splice being the part which always gives out (in my experience), is it not better to take up the continuous rope than to throw the single rope away?

I speak of my experience. This has been mostly with hemp ropes, which may account for my never having seen one break, except in the splice.

If Mr. Booth will kindly give me some information on the above questions, it may enlighten me on a number of other things spoken of in his article, about which I am somewhat in the dark.

J. H. D.

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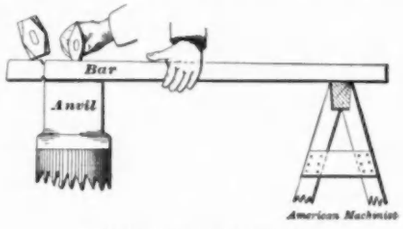
Breaking Bar Steel.

Editor American Machinist:

Tecumseh Swift's article, March 5th, "Breaking Off a Piece," brings to mind a job I had several years ago, as steel inspector, which consisted mainly of looking out for seams, pipes and breaking off



BREAKING BAR STEEL.

the ends of the bars as they came from the hammer shop.

In breaking off the ends, we did it somewhat differently from Mr. Swift's sketches. In order to get a clean, square break, we always nicked the bar on both sides, laid it flat on the anvil, held the chisel firmly on the top of bar, over the anvil, and the helper hit the end to be broken off with a sledge, as near the nick as possible and with a sharp, swinging blow, as shown in the sketch.

Mr. Swift's article has been the means of bringing several questions to mind (in addition to his original one) that I cannot satisfactorily answer, and I would like Mr. Swift or others to answer, through your columns, the following questions:

Why did the helper strike the bar near the nick, instead of on the end, as shown in Mr. Swift's sketches?

Which way of striking the bar is the most efficient, and what would the different effect of each way of striking the bar be on the man holding the bar?

What effect did holding the chisel on the top of the bar have?

Should the lower nick be directly over the edge of the anvil, or on either side of it? Give reasons why it should be in either position. W. E. B.

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Casting on Chills.

Editor American Machinist:

I am having some trouble making chilled jaws for rock crushers. I use old jaws two-thirds and one-third a good hard charcoal iron, and move the casting from the chill in from fifteen to twenty minutes after casting. I don't put them in a regular pit, but cover them thoroughly in a bed of sand for twelve hours. The chill I use has never been finished; only the sand cleaned off, and rubbed smooth with an old file. Ought not the chill to be finished in the machine shop? And do I remove the casting too soon after casting from the chill? Size of casting, 24x16x3 inches; thickness of shell, 3½ inches. The trouble is, the chill is not deep enough in the casting and seems to be soft. Anything you or your many patrons can tell me, to get those jaws right, will be highly appreciated. A. R. J.

[We referred the above to our valued correspondent, L. C. Jewett, who replied as follows.—Ed.]:

Editor American Machinist:

Early moving of casting from the mold to put in annealing pit does not affect depth of chill at all, or hardness perceptibly. Chills are machine-finished to insure their accuracy only; it does not affect their chilling qualities. The following particulars are important:

1st. The kind of iron in the mixture.

2d. The temperature it is poured upon the iron chill.

3d. The thickness of the iron chill used.

These have everything to do with success or failure. His chill is too light. Should be 6 inches (7 inches would be better) thick.

The kind of iron mentioned as used is to some extent an uncertain mixture; 66⅔ per cent. scrap and 33⅓ per cent. hard charcoal iron is not quite as certain in its results as 66⅔ per cent. No. 3 charcoal pig iron and 33⅓ per cent. scrap stone breaker would be, and it might be necessary to put in some No. 4 charcoal pig iron—depends on the way it is graded. It is a matter of experiment to get the right mixture, and keep it right.

In the working of the cupola, whether melting even or on one side, good and hot metal is imperative. Dull, sluggish iron will neither chill deep nor hard. The temptation is to pour the metal dull, to insure the unchilled parts coming smoother than if hot, and thereby sacrifice the chill.

The thicker the iron part of mold, to a reasonable degree that depends on thickness of casting, the quicker the absorption of heat, the deeper the congelation and the greater the depth the graphite is changed into combined carbon—that is, the chemical change that produces the chill.

L. C. JEWETT.

Boston, Mass.

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Breaking Off a Piece.

Editor American Machinist:

Mr. Tecumseh Swift's article on "Breaking Off a Piece" is interesting. A little information on breaking bar iron of good size, say 2 inches and smaller, may be beneficial to some of your many readers. When the end to be broken off is a foot or more long, the best way to break it is to ring it with a cold chisel; then project the cut part over the anvil, say 4 or 5 inches; then hold a heavy hammer underneath the end of the bar while the helper gives the cut part a blow with a sledge.

G. G. STAUFFER.

American Machinist.

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"New and Improved Designs."

The wise machinist does not imagine that because a machine was right and represented the advanced practice of seventeen or eighteen years ago, it must therefore be always right, and that it is an act of vandalism to undertake to improve it. As time goes on, we usually see points about our machinery that can be improved or must be changed to meet new conditions.

We can see no reason why the same rule should not apply to a journal which represents such a very progressive art as that of machine construction. This number of the "American Machinist" is somewhat changed in appearance, and we think for the better, by reducing the titles of articles and of departments to one style of type, and that one of the latest, instead of employing a mixture of a dozen or more styles, as formerly—a practice which is in some degree, comparable to using on the same machine some gear wheels with curved arms and some with straight arms, or some levers of oval section and others ribbed.

While we shall make no changes merely for the sake of changing, we shall not hesitate to make changes where there seems to be room for improvement, following in this matter the universal practice of the best machine constructors.

A Misrepresented Club.

In our issue of October 10th, last year, we called attention to the fact that the official organ of the Manufacturers' Club of Philadelphia was being used for a purpose which would be likely to lead the club into difficulties, and would almost certainly put it in a false attitude before the public. Our warning has been justified by events.

A few members of the club, devoted to silver, have succeeded in making it appear that the whole club is equally devoted to it, and is ready to sacrifice about everything else to advance its interests.

We repeat that we believe that every individual manufacturer not only has the right, but should consider it a part of his duty as a citizen to have an intelligent opinion on public questions, and to stand up for that opinion on all proper occasions. But when a few members of a manufacturers' club pervert it to a purpose utterly foreign to its avowed objects, and make it seem to take a position that would be repudiated by nine-tenths of its members, it looks as if the nine-tenths had been sleeping and had allowed themselves to be imposed upon by members not mindful of the rights of others.

The majority of the members of the club seem, however, to be very wide awake now, and to be fully conscious that the club has been misrepresented and placed in a false position before the country. It is proposed that 95 per cent. or over of the members now avow themselves for "sound money," and thus place the club right.

We suggest what we think a better plan, i.e., for the club to resolve that, as a club, it will take no part in politics, nor allow itself to be used by politicians, and then let its members who favor silver join silver clubs, and its other members join such other clubs or organizations as may suit their individual preferences, and that are organized and maintained for the avowed object of advancing a certain idea or combating an idea, as may happen.

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Thinking to Scale.

We should be able to think to scale just as much as we draw to scale or work to scale. All our ideas and estimates seem to be relative only, and it is important that the relativity be not forgotten. Time or speed, space or size, heat or cold, light or color, are all, when we really think of it, in any expression of them, relative only, and depend upon their surroundings for their values. The fastest movement of the wings of an albatross would be impossible by very slowness to the house-fly. The polar bear would swelter in the winter of the tropics. The owl cannot see by day through excess of light.

It seems to be the same with the measure of our accomplishment. We take great pride, for instance, in our fine work. Probably in nothing are we more satisfied than in the polish we can impart to the surfaces of metals and glasses; and yet it is almost possible to prove that, relatively to the size of it, the surface of this earth of ours is more highly polished than the most dazzling product of the shop.

That the earth is round like an orange is one of the first things that we learn at school. How the important truth of the rotundity of the earth was taught before the general dissemination of the orange we do not know. As the general acceptance of the fact of the rotundity of the earth was nearly coeval with the general dissemination of the orange among civilized peoples, these two events may have each awaited the other.

However that may be, not many scholars have learned the whole lesson of the orange. By means of it we can at least make out a pretty good case for our polishing proposition above. Take an orange, say, two inches in diameter, which is small as oranges go, but which will be most convenient for us to figure with, and has the merit of being cheap. The earth being 8,000 miles in diameter, the orange, as its representative, is on the scale of one-quarter of an inch to a thousand miles. One mile, then, on the earth corresponds to one-quarter of one thousandth of an inch (.00025 inch) on our orange. The highest mountains on the earth are not nearly as high as the mottling or roughness on the surface of the smoothest orange. A ploughed field with six inches of depth for the furrows would be represented on the orange by a measure of .000000023674 inch, which is less than one-quarter of one ten-millionth of an inch.

This kind of reasoning puts us in a suitable state of mind for thinking to the scale suggested by Professor Arnold, in his valuable paper on "The Study of Iron and Steel by Micrographic Analysis" in our issue of March 12th. A wide and prolific field for the investigator is opened by the single suggestion that "metals should be regarded as crystallized igneous rocks," the metallurgist becomes at once a microscopic geologist, and no limit may be set to the revelations that may be expected.

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Quarter Century Club of Employes.

Advertisements are of various scope and character, and those most valuable and effective cannot, after all, be bought and paid for. Some of them take long to make, however. Thirty-two employés of a well-known firm, representing every grade from that of superintendent down, and who had been in the employment of the firm for twenty-five years or over, were recently given a dinner, and a Quarter Century Club was formed and fully organized, to which other employés will be admitted as they complete their quarter of a century of work. At the dinner mentioned there were those who

had scored thirty, thirty-five and forty years of service. We offer our congratulations and our heartiest wishes for the success and growth of the Brown & Sharpe Quarter Century Club.

The business represented by the Brown & Sharpe Manufacturing Company was founded in 1833 by David Brown and his son, Joseph R. Brown. David Brown retired in 1841, and the business was conducted by Joseph R. Brown until 1853, when Lucian Sharpe became his partner. The company was incorporated in 1868.

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Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(70) W. C., Waltham, Mass., incloses a diagram from our issue of April 18, 1895, and writes: Did you not commit an error in using the sine of an angle of 15° = .2588 instead of the tangent .2679? A.—Such a mistake was evidently made; the line *E G* is a tangent, and its length should have been computed .2679 × 2 = .5358.

(71) L. I. F., ——— writes: We have a 48-inch pulley on a shaft which is to be driven at 175 revolutions per minute. Now, suppose the engine crank shaft has on it a pulley of the same diameter—that is, 48 inches—and the engine runs at the same speed (175 revolutions), will it require the same width of belt as would be required if the pulley on the engine shaft were 24 inches diameter and the engine running at 350 revolutions per minute? A.—As the belt speed under the two conditions named would be the same, and the same work would, of course, be done, the width of the belt would be practically the same. Some difference might result, however, from the fact that, when using the smaller pulley on the engine shaft, the belt contact on this pulley would be for an arc of less than 180 degrees, and if the pulleys are quite close together this decrease of the arc of contact might make a difference and require a wider belt to overcome it; but unless the width of the belt is quite closely calculated for the work to be done, there will be no practical difference in the two cases.

(72) J. W. K., Elmira, N. Y., sends us a sketch which it is not necessary to reproduce, of a train of gears consisting of, first, a large gear of 48 teeth engaging with a pinion of 12 teeth; then, on the same shaft with this, another gear of 48 teeth driving another pinion of 12 teeth, and then a 48-tooth gear driving a wheel of 24 teeth. The first gear is designated *a*, and the last is designated *b*. He asks: How much pressure at *a* with a flat spring would I require to produce 5 pounds pressure on *b*, running half an hour at about 60 revolutions per minute? Is it possible to make a spring that will give that amount of pressure? If it is possible, what dimensions had I better make it? A.—We consider the scheme entirely impracticable, and that it would not be worth while to go into any computation in connection with it, even if we had been provided with the necessary data. The question asks for dimensions, while absolutely no dimensions are given to start from. We do not know whether the pressure of 5 pounds, which it is desired to be realized at *b*, is to be at the periphery or elsewhere, and we have, at that, no hint of the size of the wheel, so that we have no data that will enable us to bring it to a horse-power basis. It does appear, however, that the last wheel would turn 1,800 revolutions in the half hour, while the first wheel would make 56¼ revolutions, and it would require an enormously long spring to stand as much winding as that. We have an eight-day clock that runs upon a winding of one turn per day, or seven turns per week. The tension and driving power of the spring when fully wound up would be, of course, much greater than when nearly run down, so that some compensating mechanism should be provided for that also.

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Business Specials.

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear wheels, gear cutting. Grant; see page 27.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Engine castings ⅛ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Aluminum and Brass Castings, Machinery, Name Plates. Twining Campbell, Paterson, N. J.

Marine Iron Works, Chicago, builders of steam yachts and marine machinery; catalogs free.

Mannocitin permanently prevents rust. Testimonials explain. O. Goetze, 14 Whitehall st., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Key Seaters for any length of hub or width of keyway. New, handy machines. Mitts & Merrill. 913 Tilden street, Saginaw, Mich.

Duplex and special gear cutters, counterbores, cutter and surface grinders, vertical millers, hand punches and shears. R. M. Clough, Tolland, Conn.

Patent Soliciting of High Class.—D. Walter Brown, Counsel in Patent Cases, 111 Broadway, New York. Send for "Brief History of Patent Legislation."

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The Uses and Advantages of a Public Supply of Compressed Air.

BY FRANK RICHARDS.

Air Hoists.

In the business part of every city there is always much lifting to be done, in the loading and unloading of goods in mercantile establishments, in stacking up and in taking down goods in storage, in manipulating in process of manufacture, and in packing or unpacking goods. Many men are employed merely for their physical strength, and their work consists largely of lifting. There can be scarcely an establishment manufacturing or selling goods, or merely storing them, where hoisting facilities are not a necessity, or at least a great convenience.

The more perfect and satisfactory the devices provided for hoisting, the more widely and generally are they adopted. The differential chain hoist has not only superseded the old rope pulley blocks, but has replaced them in a ratio of perhaps ten to one. These hoists are still far from satisfactory. They are slow in operation; they require considerable manual labor for the hoisting, and often also for the lowering; they cannot be used under all conditions; and in establishments where a supply of compressed air has been provided, the air hoist has driven out the chain hoist as completely as that has superseded the rope pulley blocks. The same process would be inevitable with the general public if the air were provided.

For the work of hoisting, compressed air seems to be peculiarly adapted, and it is proper to look a little into some of the applications of it for this purpose, and also at the cost of its employment. It will be like beginning at the beginning to take first the simple, direct-acting, vertical cylinder, suspended hoist. The air supply, it is to be remembered all along, comes to us at 100 pounds gage pressure, and costs 5 cents per 1,000 feet of free air.

The hoists of this kind are not generally fixed in one spot. The hoisting to be done is usually the lifting of an article in one spot and depositing it in another, so that the hoist may be suspended from the arm of a crane, or more frequently to a trolley running upon an overhead rail, sometimes straight and sometimes led around curves to any point required. If the distance to be traversed is not great, a small hose connecting the hoist with the supply pipe is not detached. If the distance is too great for this, it seldom happens that the air is required at both ends of the route; so that where the hoisting is done, a hose is attached by an instantaneous coupling, and again instantaneously uncoupled until wanted again.

Say that we have a hoisting cylinder 6 inches diameter, with a piston rod or hoisting rod 1 inch diameter, and capable of lifting 4 feet or more. Then, using the air in the cylinder up to an effective pressure of 90 pounds, the lift of the hoist will be:

$(6^2 - 1^2) \times .7854 \times 90 = 2{,}475$ pounds.

If this weight is lifted, say, 4 feet, the volume of air used will be:

$(6^2 - 1^2) \times .7854 \times 4 \div 144 = .7636$ cu. ft.

To this we add 30 per cent., to cover all possible contingencies:

$$.7636 \times .229 = .9926$$

and we will call this 1 cubic foot. The one loss that seems to be inevitable, and which is included in our 30 per cent. allowance, is in taking up the slack of the hoisting chain, or other means of attaching to the load, before the hoisting actually commences, so that a certain portion of the cylinder must be filled with the compressed air, besides the actual 4 feet of travel for the lift. As the air in the cylinder is up to a pressure of 90 pounds, or 7 atmospheres, the volume of free air used will be 7 cubic feet, and the cost of this will therefore be $\frac{7}{1000}$, or $.007 \times .05 =$ $0.00035, and this is all we have to pay for lifting more than a ton a height of 4 feet. A hundred such hoists will be made, of course, for $0.035, or 3½ cents.

If the weight lifted or the height of lift were less, the volume of free air used would also be less. Thus, if the weight were only one-half as great, or 1,237 pounds instead of 2,475 pounds, the pressure of air required would be but 45 pounds, gage, or 4 atmospheres, and the

cost would be $0.00035 × ½ = $0.0002, and for one hundred lifts of this weight the cost would be two cents. The cost for one-half the weight, it will be noticed, is somewhat more than one-half, because one-half the working pressure of the air is more than one-half of the absolute pressure. So, also, if the maximum weight were lifted only to one-half the height, or 2 feet instead of 4 feet, the cost would be somewhat more than half, because the loss in clearance would be more than half, or might, indeed, be as much in one case as in the other. The air cost for cases where the weight is lifted only enough to clear a wagon or a bench or a machine, and then lowered to the ground, will be the same as for lifting from the lower position to the higher, because the cylinder would be filled with the same volume and pressure of air in either case.

The one objection to the direct-acting, vertical cylinder air hoist is, that the height required up to the point of suspension is so great. About three times the maximum lift of the hoist must be provided for. Where this necessary height cannot be secured, a horizontal cylinder is used, the apparatus being suspended at two points at or near the ends. With this arrangement the height objection entirely disappears, as less height is required than for a common chain hoist. These horizontal cylinder hoists are also made with sheaves, using either chain or wire rope, to multiply the hoist travel twofold, fourfold, or to any extent desired. Under any of these arrangements the proportional air cost for the lift is practically the same. The speed of hoisting or lowering is completely under the control of the operator, and may be as fast or as slow as may be desired.

The accompanying table, which might be greatly extended and still not cover all the actual conditions of service, will be found of interest, especially in the idea that it conveys of the cost of air hoisting. It is probable that many persons will be surprised at the figures. In connection with the low cost of the air, it is to be remembered that the hoists also are simple and cheap:

AIR HOIST TABLE.

A TABLE *of the lifting capacities of direct-acting air hoists, with volume of free air per lift and cost of air per single lift and per hundred lifts, with a maximum lift of 4 feet and a maximum pressure of 90 pounds. Air furnished at 5 cents per 1,000 feet of free air.*

Diameter of Cylinder.	Effective Area of Piston.	Maximum Weight Lifted.	Cubic Feet of Free Air for 4 Feet of Lift.	Cost of Air per Lift.	Cost of Air per 100 Lifts.
2	3.05	274	.74	$0.000037	$0 0037
3	6.87	618	1 67	.000084	.0084
4	12.22	1,099	2.97	.000149	.0149
5	19.09	1,718	4 64	.000232	.0232
6	27.49	2,474	6.68	.000334	.0334
7	37 42	3,367	9.09	.000455	.0455
8	48.87	4,398	11.88	.000594	.0594
9	61.85	5,566	15.03	.000752	.0752
10	76.36	6,872	18 56	.000928	.0928
11	92.39	8,315	22.46	.001123	.1123
12	109.96	9,896	26.73	.001337	.1337

Latent Heat.

A great many intelligent and generally well-informed people have a very incorrect, or at least a very inadequate idea of what is meant by the term "latent heat," or of what actually occurs in the conversion of water into steam. We reproduce verbatim a communication which we received some time ago, and which gives us a good opportunity of saying a word or two on the above topic. There is certainly not the slightest intention of giving offense to anyone, but that such a letter could be written in good faith certainly affords a justification of our attempt at enforcing what is evidently a needed lesson. The communication is as follows:

"A power plant has two horizontal return tubular boilers designed for 100 pounds pressure and supplying steam to a 200 horse-power compound engine. This engine is capable of working at 150 pounds pressure and developing 300 horse-power. The owners require an additional 100 horse-power, but do not wish to change the present boilers or engines. It is proposed to put in a 100 horse-power Manning boiler, suitable for 150 pounds pressure, and to work all three boilers, pumping the feed water into the horizontal boilers, where it would be heated to about 335 degrees, then with a special pump taking the water from the bottom of these boilers, at the above temperature, and delivering it to the Manning boiler, which is expected to supply the 300 horse-power engine with steam at 150 pounds pressure. The steam valves on the horizontal boilers would be kept closed, these boilers being used as feed-water heaters only. Will this arrangement work? And is there a pump which will handle water at 335 degrees? Of course, the water at this temperature would be forced to the pump at about 100 pounds pressure."

This communication is very clearly written, and there cannot be the slightest misunderstanding as to what it is proposed to do. As the two boilers are to raise the temperature of the water to 335 degrees corresponding very nearly to a gage pressure of 100 pounds (337 degrees is given in most of the tables), the third boiler is assumed to raise the temperature of the water up to that required for 150 pounds pressure, which would be 365 degrees, and that is evidently all that would be expected to be done to get the steam required. To make the scheme perfectly consistent and symmetrical, the first boiler should raise the temperature to 297 degrees, corresponding to a gage pressure of 50 pounds, the second to 337 degrees for 100 pounds, and the third, as before, to 365 degrees for 150 pounds.

Now, assuming this arrangement to produce the steam for the engine as proposed, it would mean that we would nevermore be able to boil our potatoes, but would have to eat them either raw or roasted. The everyday experience of every cook, from the foundation of the world, would be all upset, and the conditions of living would require to be all learned over again. As the water approached the boiling point, it would become more dangerous than gunpowder. In the olden time, our ancestors heated the water for boiling by heating stones in the fire and then dropping them into the water. In that case, under the theory suggested in the above communication, the addition of the last stone would have converted the entire pot of water into steam at once, our ancestors would have been wiped out, and then where would we be? The latent heat of steam may to many seem to be heat wasted, but it at least guarantees to us comparative safety in some of our operations.

The operation of boiling water, and of converting it into steam in a steam boiler, is precisely the same as the boiling and evaporation of water that is not inclosed, the shell of the boiler merely enabling the operation to be carried on under a higher pressure. Between boiling in the open air and boiling in a steam boiler is not the difference between boiling under no pressure in the one case and boiling under pressure in the other. It is only the boiling under a lower pressure in one case and under a higher pressure in the other case.

Take a pint, or a pound, of water in a small tea-kettle, and place it over the flame of a gas stove. The gas stove is most convenient, because the flame is likely to continue nearly constant, but any other means of heating will do well enough. Say that it is in the winter, and we start with the water as cold as it can be, and that it takes ten minutes to heat the water up to the boiling point or to make it begin to boil. Now, we don't need to be told that the water does not all flash at once into steam as soon as the boiling point is reached; but we may be surprised to find how long it takes to boil it all away. If it takes ten minutes to heat the water from the freezing to the boiling point, it will take fifty minutes more to boil it all away, or it will take an hour in all for heating the water and convert-

ing into steam if it takes ten minutes for the first heating of the water.

A good idea could be got of the steaming capacity of any boiler from the time that it takes to get up steam, only that the fires are not at the best for the whole time. Boilers may easily lead to mistaken estimates of their evaporative power. It may require five times as long to get up steam in one boiler as in another with the same grate surface; but if it also has five times the weight of water to heat, the boilers may still be very nearly equal in steaming capacity.

If, instead of having an open tea-kettle, we could have stopped the spout and fastened down the lid, and could have raised the temperature of the water up to 365 degrees, and the pressure of the steam up to 150 pounds, and then have blown it off at that pressure until it was all gone, we would have found that it would have taken considerably longer to have heated the water up to the higher temperature required, while the total time required for heating the water and converting it all into steam would be only a little longer than before. It might take nearly twenty minutes to heat the water up to the boiling point for 150 pounds pressure, while it might not take more than five minutes over the hour from the time of starting with cold water until it was all converted into steam.

These are, of course, only very rough approximations, but they may still serve to give an idea of the relations and the relative proportions of sensible and of latent heat in steam. The heating of the water up to the evaporation temperature for the required pressure imparts sensible or thermometrical heat to it, and after that the conversion of the water into steam is done by imparting latent or non-thermometrical heat to it, and the latter is always the bigger job.

Supposing the three boilers referred to in the communication above to have been of equal capacities and to have had equal grate areas, the employment of one boiler instead of two for heating the water would have been somewhat in excess of the proportional requirement for the whole series, even assuming the feed water to have been at 32 degrees and the water to have been heated up to 365 degrees—the full temperature required for 150 pounds pressure. While the sensible heat required would be 338 units, the latent heat required in addition to this would be 855 units, or more than double as much. The arrangement suggested, even if the proportions were rightly adjusted, is not a practical one.

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A Fast Horse.

At a recent meeting of the Engineering Association of the South, at Nashville, Mr. Calhoun, in discussing wire ropes, mentioned the interesting practice of the miners at the Whitewell mines in getting down the 1,200 feet from the mouth of the mine to the village. This is done by means of a "horse" (besides which the noted Salvator is as a tortoise to a hare), which they place astride one of the rails of the incline, and sitting down on it, they use their heels, placed on the rail in front of them, as a brake, and the hand, protected by a leather palm and placed on the haulage rope, serves to steady them. The descent is accomplished at speeds varying from 30 to 60 miles per hour. Experts in this business scorn to touch the rope, but balance themselves by a skillful use of the center of gravity.

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The next issue of the "American Machinist" will be devoted to a notable gun lathe and to modern gun-making methods. It will be a number of exceptional interest to all who have anything to do with machinery.

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Commercial Review.

NEW YORK, SATURDAY EVENING, MARCH 28.

Iron Working Machinery, etc.

Improvement in the New York machine tool market is still as illusive as an ignis fatuus. The number of sellers who assume a tone of greater hope is so small that it is hard to say whether there is any betterment in the situation at all. Perhaps there may be some, but, if so, it is the reverse of radical. A representative of one concern doing a pretty general business tells us that the market is actually quieter than it has been.

The demand for tools for bicycle manufacture has evidently reached, if not passed, the deepest point of its seasonable dulness, it having for months been on the wane. But it seems to continue still an important factor in the market. One party thinks that there is already beginning to be a resumption of the bicycle tool trade for the new season. An impression exists that the end of this industry is not yet, and that, for another year or perhaps longer, buyers representing it will lend substantial aid to the market. The end must, however, come sometime. It seems to us that bicycle manufactories are getting to be unduly numerous, and that the reaction which is likely to follow may be comparable with that which succeeded last summer's abnormal activity in iron. The question is, what will take its place?

The prices of the largest lines of tools are exceedingly close. Rates on the smaller tools are better held. For this they are largely indebted to the bicycle trade.

There are at least two of the local concerns which have been talking bullishly this year, and one of these now states that its business so far has been more than double that of a year ago.

Some illustrations of the general situation, in its various aspects, may be derived from the following letters. A machinery manufacturing firm in this section of the country say: "We have been fairly busy during the present month. We think this month will compare favorably with last month's business. We find, however, there are not as many inquiries as before, and we presume the business will not be as satisfactory as it was a year ago, as we were quite busy then. On the whole, we think business is quite up to what we anticipated it would be this year."

Speaking of engine lathes, another concern says: "Although this month is better than last and better than a year ago, the outlook is not favorable and prices still hold low."

The Bullard Machine Tool Co., Bridgeport, Conn., write as follows: "So far as our observation extends, the tool builders catering to the bicycle trade and small electrical appliances, are in the enjoyment of a regular boom so far as volume of business is concerned, but at low prices, while the builders of the heavier class of machine tools, required for locomotive, steam engine and general machine work, are 'enjoying' a particularly dull time. With us, however, the present month is an improvement upon the two previous months of the year, and the first quarter of this year is a decided improvement upon the corresponding quarter of last year. As to the future, can only say that we live in hope."

In respect to hydraulic machinery, we will speak for two principal manufacturing concerns in this city, without expressing a decided opinion as to the general situation, which may perhaps, be less favorable. Watson & Stillman have done, in January and February, some 10 per cent. more actual work in their shop than at that time last year. As to orders, they consider the amount now on hand sufficient to last until some time in July. But they say prices on all their goods, which comprise a very miscellaneous line of hydraulic machinery, are lower than last year. They do not think it is possible to make an advance while other concerns continue to quote low. The business of R. Dudgeon, also, in hydraulic hoists and punches, is reported better than that of last year. This concern does not expect to make further reduction in prices at present.

Wood Working Machinery.

The wood working machinery market, as regards the demand coming from this immediate neighborhood is nothing less than sepulchral. And for dry bones to fill it, there is plenty of second hand machinery. But wood working machinery does not expire without being able to tell what struck it. It is always ready to find a verdict at its own inquest. One of the latest we have heard of is the eight hour labor custom in this vicinity, which is thought to render it cheaper to ship the lumber ready dressed from other cities of the State where ten hours are the rule,

than to work it up in local shops. This is but one of many reasons that have been assigned for the dulness of the trade about here.

Fortunately for the wood working trade the conditions are more favorable among buyers in some parts of the country than with those in this immediate neighborhood. We occasionally hear favorable statements as to the West. However, it is probably not all one grand, sweet song, even there.

A representative company, the J. A. Fay Co., of Cincinnati, write as follows: "We do not know that we have observed any extraordinary signs of improvement in business thus far this year, over the same number of weeks of the preceding year. We have observed the fact that there are a great many more inquiries for wood working machinery, the visitors to our factory for the purpose of inspecting machinery are more frequent than they have been for some time past, but it seems as though many of the visitors were simply looking about, preparing for something they anticipate they will need when business does assume more of its normal conditions. We find our customers just as clamorous for low prices as they have been for the past two years, and while we must pay more for some raw materials than we did a year ago, we have not been able to stiffen up on prices of our machinery. We, however, are not discouraged; the indications are for a better trade in the near future. We have been busy in our designing departments for some time past, bringing out improved tools and preparing for the increase of business when it does come. In some sections of the country, our business is about normal, in other sections the trade seems to be demoralized. Foreign trade is brighter. Our business last year increased about 25 per cent over 1894."

The iron market, generally speaking, is still quiet. This seems to be especially so in Northern irons, although one large concern is doing some business worth mentioning. But in Southern irons, in which the concessions have been great, considerable business is being done throughout the country.

The metals are commonplace.

It is said to be as yet unpublished, that some Japanese antimony, according to an Imperial assay at the mint at Osaka, Japan, has shown a purity of 99.48 per cent. By a test in this country, a result of 99.44 per cent. has been obtained.

We print below a report of the trade conditions prevailing in Pittsburg for the month of March up to the latter part.

Pittsburg Report for March.

The general iron trade, during the past few weeks, has not shown much change. It may be said to be still in a very unsatisfactory condition. The temper of traders appears conservative, yet strongly hopeful. Mills are well employed on orders, but the general demand is limited, and the crude iron market remains dull.

Production continues in excess of consumption. Furnacemen are making little effort to force business, and sellers are disposed to hold their trade.

It is evident that the capacity of furnaces in operation is greater than the demand; so prices are weak or at least hesitating. It would appear, then, that until the consumption increases sharply there can be no considerable advance in prices, while it is just as clear that with the present high price of raw material there can be no considerable decline.

It is expected that, for some time to come, business will be confined to narrow limits. Speaking for the entire market, there appears to be the same difficulty, that while a great many people believe that better conditions are coming in the near future, few are willing to make an immediate move.

During the past month the engine and boiler business improved slightly. In the the engine line there seems to be an increasing demand for high-speed engines for electrical purposes, especially for direct-connected work. Engine builders are holding themselves in readiness for a large trade during spring, which is confidently expected.

One promising field for engine builders is that of water-works construction. Many new plants are contemplated throughout the States of Pennsylvania, Ohio and West Virginia. The Ball Engine Company, of Erie, Pa.; the Westinghouse Machine Company, of Pittsburg; the McEwen Company, of Ridgway, and other large establishments, are well filled with contract work.

The boiler business is also gradually assuming its former shape. Not many heavy contracts have been placed, but there is a hopeful prospect of such work. W. F. Patterson, representing the Erie City Iron Works, has been successful in securing a number of fair-sized orders. Prices are still in the shady corner, but there are good prospects of an early advance. Feed-water heaters, separators, steam pumps, etc., are selling in a fair way. F. R. Dravo & Co., of Pittsburg, agents for the Harrison Safety Boiler Works, have placed several of the largest sized separators in this city lately; also in the Valley district.

In pumps, the prices seem to rule a little easier than in other specialties, and it is stated that buyers are willing to pay rather more now for a good article. Valves, fittings, injectors, gages, and other steam supplies, are being called for daily. This market is generally a fair way, but at present it is extremely good. Belting is being sold well. Somers, Fitler & Clarke, of this place, extensive dealers in mill supplies, etc., have secured several large

Help Wanted.

Situation and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our **subscription** list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted.—An accurate machinist. Marine work. Charles Ward, Charlestown, W. Va.

Mechanical draftsman and first-class tracer is open for engagement. Address G. L., AM. MACH.

Situation wanted by pract. mech., exp. dftsman. and mach'st with tech. educa'n. Phi., AM. MACH.

Position wanted by draftsman, experienced in locomotive and general mach. Box 79, AM. MACH.

Expert planer hand wants position as foreman or journeyman; large exp. Ad. Box 76, AM. MACH.

Wanted—Position as foreman by a thoroughly up-to-date pattern maker. 14 years' experience; age, 40 years. Box 64, AMERICAN MACHINIST.

Practical and successful designer; A1 draftsman; 20 yrs. varied exp. High grade eng. a specialty. Now open for eng. Address Box 263, Ridgway, Pa.

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Miscellaneous Wants.

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M. York, Clev'd, O.

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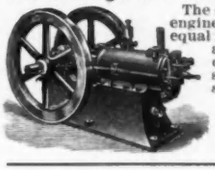

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orders from Altoona, and also from Ohio parties, for mine equipments.

In heavy machinery, such as drill presses, cranes, bolt cutters, grinding and polishing machines, hammers, etc., makers find the market to be of an improving nature. The Frank Kneeland Machine Company recently made shipment of a 22-inch merchant mill for the Illinois Steel Company, and made a 4½ x 4½ pair of lever shears for scrap-yard purposes. These are said to be the largest shears ever made. Heyl & Patterson have contracted to put in a slag conveyor plant for the Cambria Iron Company, of Johnstown.

All in all, the opening of spring trade has not brought the improvement in the general markets that was expected. Easier money was expected to induce large purchases, but buying has not yet attained large proportions, and some doubt upon the subject is now beginning to be felt.

Quotations.

NEW YORK, Monday, March 30th.

Iron—American pig, tidewater delivery:	
No. 1 foundry, Northern	$12 25 @ $13 25
No. 2 foundry, Northern	12 00 @ 12 50
No. 2 plain, Northern	11 25 @ 11 75
Gray Forge	11 00 @ 11 75
No. 1 foundry, Southern	11 50 @ 12 00
No. 2 foundry, Southern	11 00 @ 11 50
No. 3 Southern	10 25 @ 10 50
No. 1 soft, Southern	11 25 @ 11 75
No. 2 soft, Southern	10 75 @ 11 00
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Bar Iron—Base, in Carloads—Mill price, on dock: common, 1.17½ @ 1.25c.; refined, 1.25 @ 1.45c. Store prices, f. o. b.: common, 1.40 @ 1.50c.; refined, 1.50 @ 1.70c.

Tool Steel—Ordinary sizes, standard quality, 5¾ @ 7c.; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—From store, about 1.75c. Special brands upward.

Cold Rolled Steel Shafting—Base, 2½c. in carloads; 2¾c. for smaller quantities from store.

Copper—Carload lots, Lake Superior ingot, 10¾ @ 11c.; electrolytic, 10⅝ @ 10¾c.; casting copper, 10⅜ @ 10½c.

Pig Tin—For 5 and 10 ton lots, 13.40 @ 13.50c., f. o. b.

Pig Lead—In carloads, about 3.10 @ 3 12½c., f. o. b. Higher, perhaps, for larger quantities.

Spelter—In carload lots, New York delivery, 4.15 @ 4.20c., for ordinary brands.

Antimony—Cookson's, 7¾ @ 8c., according to quantity; Hallett's, 6¾ @ 7c.; Japanese, 6¾ @ 6.85c.

Lard Oil—Prime city, 50 @ 52c., in carload lots.

▲ ▲ ▲

New Catalogs.

There are three sizes of Standard Catalogs, first authorized by the Master Car Builders' Association, 9" x 12", 6" x 9" and 3½" x 6". We recommend the 6" x 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

The Brass & Iron Works Co., Fostoria, O., issue a pamphlet devoted to the illustration and description of pipe, nipple and bolt-threading machines. Several varieties of such machines are shown some of them having new points of construction that are of interest. The pamphlet will be sent to those interested on application, and is standard size, 6 x 9 inches.

Smith Sons' Gin & Machine Co., Birmingham, Ala., send us a catalog illustrating and describing cotton ginning machinery, feeders, condensers, presses, elevators, and other machines for working and handling cotton. The catalog shows quite a complete line of machinery of this class, and contains a telegraph code. It is sent to those interested, on application, and is standard size, 6 x 9 inches.

Manufactures.

An electric plant will be shortly installed at the new mills of W. J. Dickey & Sons, at Oella, Md.

A refrigerating and ice plant will be soon installed at Huntingdon, W. Va., by Frederick Gardner.

Otto Mergenthaler & Co., Baltimore, Md., manufacturers of the Mergenthaler Linotype Machines, are in the market for new tools.

The Clement Pneumatic Tool Co., Camden, N. J. has been formed with capital of $100,000. Incorporators—John W. Emery and Thos. Scattergood.

The Hart & Crouse Co., Utica, N. Y., capital $226,000, has been incorporated to manufacture furnaces and boilers. Incorporators—Gilbert Hart and C. B. Crouse.

Mr. Henry F. Hill, who was formerly with Hill, Clarke & Co., of Boston, Mass., has established himself as a dealer in machinery at 123 Oliver street, Boston, Mass.

The Hubbard Shovel Works Pittsburgh, Pa., which were recently destroyed by fire, will be immediately rebuilt, contracts for part of the work having been already let.

D. T. Lane & Son, of Franklin, Pa., are to build a larger machine and blacksmith shop, their present ones being too small. The ground has been purchased, and operations will be begun at once.

Plans are being prepared for a repair shop for the Naval Station at Port Royal, S. C. E. D. Matthews, Chief of Bureau of Yards and Docks, Washington, may be addressed for further information.

The Davis & Egan Machine Tool Co., of Cincinnati, O., have leased a new store in New York city, at 107 Liberty street, and are shipping a large amount of machinery, which will be carried in stock at the new location.

Snyder & Metcalf, of Waterford, N. Y., announce that they have purchased the Gage Machine Works, and will continue the business. They will manufacture Brush machinery, Monitor and Fox lathes, engine lathes, shafting, pulleys and hangers, etc.

It is reported that the Bar & Knife shop, at Springfield, O., which was built for the purpose of making cutter bars and knives for harvesting machinery, is to be converted into a bicycle factory, and that Gov. Bushnell, of Ohio, is interested in the project.

Messrs. McIntosh, Hemphill & Co. have just purchased a large tract of land at Pittsburgh, Pa., and have let contracts for the erection of buildings, which, with the machinery, will cost $300,000. This new plant will turn out a patent cold-rolled steel car truck.

The Clover Creek Limestone Co., Clover Creek, Pa., has recently been formed, and is about to open large quarries, for which purpose a large quantity of the most improved mining machinery will be required. The capital of the new company is $300,000.

Watson & Stillman have for some little time been at work upon a lot of hydraulic machinery for the new American Pulley Works, of Philadelphia, which is to manufacture a new all sheet-steel pulley, in which the hub, spokes and rims are all made of this sheet steel.

The Turner Machine Co., makers of hatting machinery, have purchased the entire plant of the Danbury Machine Co., Danbury, Conn. At this same place a new concern, known as the New Machine Co., has been organized, which will engage in general machine work.

The Nuttall-Dodd Co., of New York City, is a new corporation which has been formed for the purpose of maintaining a machine repair shop. The directors are Messrs. John Nuttall and J. A. Hudson, of New York City, and A. T. Dodd, of East Orange, N. J. Capital, $16,000.

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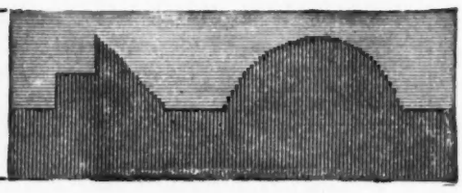

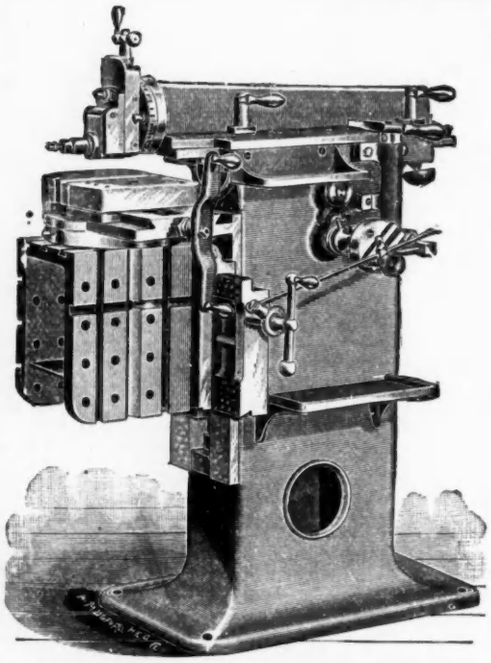

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It has Adjustable Table for planing Taper Work.

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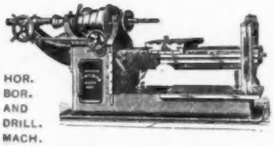
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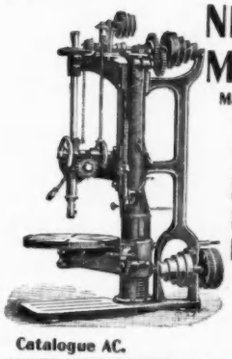
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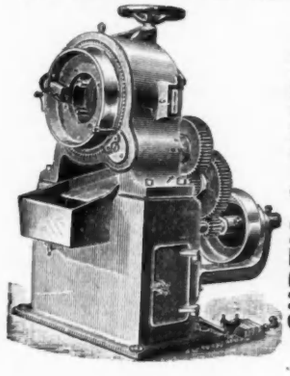
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W. A. Wilson, Rochester, N. Y., is making a lubricator, especially adapted for use on elevators and hoists. It is so made that at suitable intervals a pawl and ratchet device forces a prescribed amount of lubricant on to the worm gearing, or other part of the mechanism requiring it.

Messrs. Myron Bros., of Lowell, Mass., are about to commence a new boot and shoe factory at Greenmont, near Lowell. The factory will be built of wood, will be 50x125 feet, and three stories high. The Lowell, Lawrence & Haverhill Electric R. R. will supply the motive power.

W. H. Mathai, Jas. E. Ingram, and others of the Mathai-Ingram Co., manufacturers of sheet-metal goods, Baltimore, Md., have applied to the Legislature for a charter for the Lexington Company. They will manufacture mechanically propelled vehicles. Some form of oil engine will probably be used.

Watson & Stillman of this city have received from a Brooklyn company orders for the building of fifteen draw benches for bicycle-tube manufacture, each of them sixty feet long and with a stroke of eighteen feet, and subsequently for at least one more of the same length and stroke, but still more powerful.

Littlefield & Kennedy have started a shop at Lynn, Mass., for the manufacture and repair of electrical machinery. They have put in a number of tools and will require no more at present. Both are graduates from the General Electric Company. Mr. Littlefield is well known as an expert on electrical work.

At Berlin Falls, N. H., the Berlin Manufacturing Company is to start its saw mills about April 15th, after a period of idleness last ng four months. It is the intention of the company to add a furniture-making department as soon as they succeed in getting the necessary space built, and machinery put in for this new branch of the work.

The Michigan-Peninsular Car Co., of Detroit, Mich., have placed contract with the Berlin Iron Bridge Co., of East Berlin, Conn., for a new foundry building 160 feet square. This building is one story high, has a steel framework throughout, and is so designed that the lower chords of the trusses support runways extending the whole length of the building. These runways carry trolleys having a capacity of 2,000 pounds, for carrying crucibles to any part of the floor.

The Bethlehem Silk Company, Bethlehem, Pa., have had plans prepared for an addition 250 by 107 feet, to be erected to the rear of the present building. It will be entirely fireproof, and will be fitted out with elevators, fireproof stairways and all modern conveniences. The new structure, when completed, will have a capacity for employing 300 hands. The plans have been prepared for contractors to present estimates. Bids will be received shortly, and as soon as the contract is awarded, work will be begun and pushed to completion.

A new mechanical laboratory is being completed for the New Mexico College of Agriculture and Mechanic Arts, at Mesilla Park, N. M. The Board of Regents has appropriated a liberal sum for additional equipment. Besides a steam-heating plant, these additions will consist of one 30 H. P. automatic engine for service and experimental purposes; one 40 H. P. boiler, feed-water heater and purifier, duplex boiler feeder, steam separator, indicator, etc. Also two engine lathes, one of 16" x 6' and one 14" x 8'; one 24" x 24" x 6' planer; one 12" shaper; one No. 1 milling machine; one emery grinder, with wheels for wet and dry work; one 22½" power drill, pulleys, shafts, belts, etc. Also two wood lathes—one of 12" x 6' (plain), one pattern-maker's lathe 18" x 10'—both lathes having iron shears; one scroll saw; one 20" x 6' top-roll planer, with knife grinder; one 1-ton cupola furnace, and a large order of small tools and machine attachments. F. W. Brady is Professor of Engineering.

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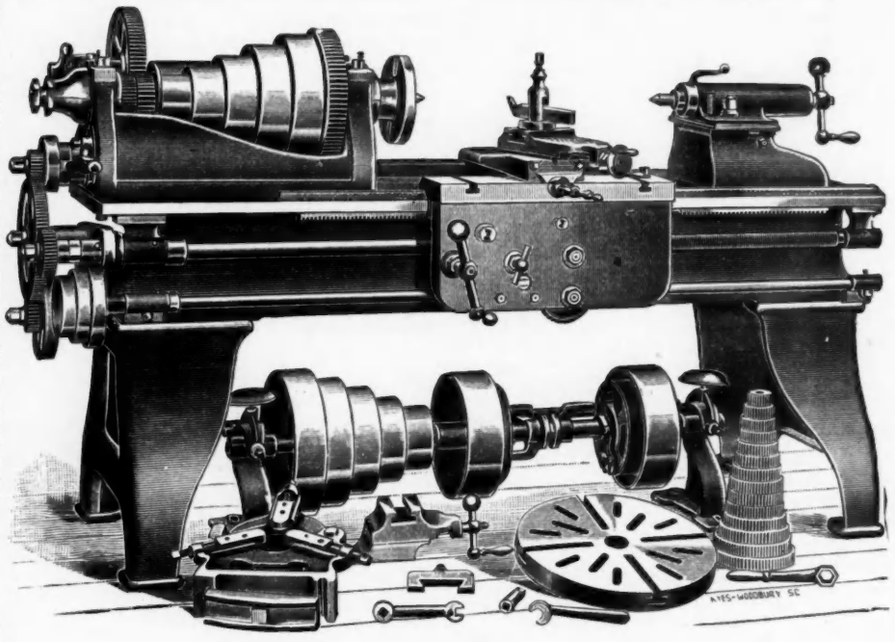

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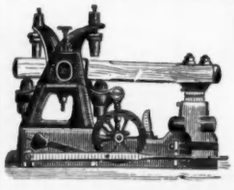

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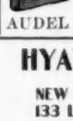

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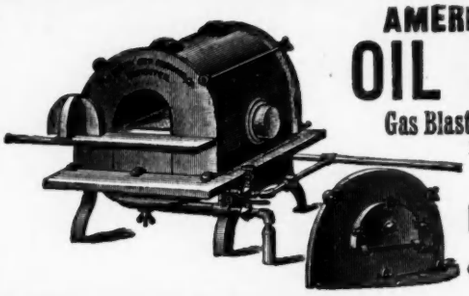

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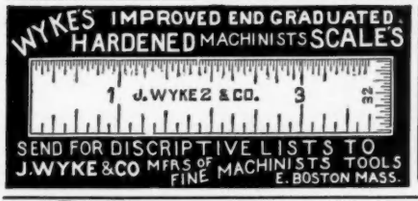
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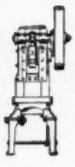

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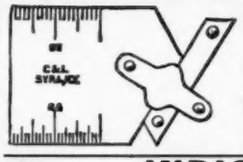

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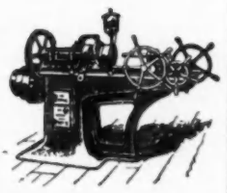

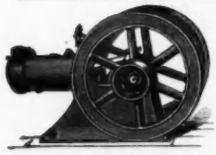

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Davis, W. P., Rochester, N. Y.
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Dietz, Schumacher & Co., Cincinnati, O.
Fitchburg Machine Works, Fitchburg, Mass
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Quint, A. D., Hartford, Conn.
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Wilkinson & Co., A. J., Boston, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

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Wyke & Co., J., East Boston, Mass.

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Abbott, Wheelock & Co., Boston, Mass.

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Cleveland Twist Drill Co., Cleveland, O.
Montgomery & Co., New York.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Syracuse Twist Drill Co, Syracuse, N. Y.

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Frick Co., The, Waynesboro, Pa.
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Continued on page 32.

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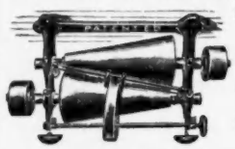

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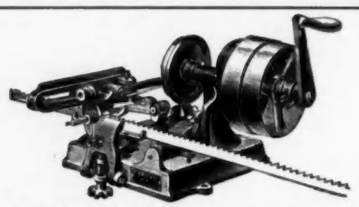

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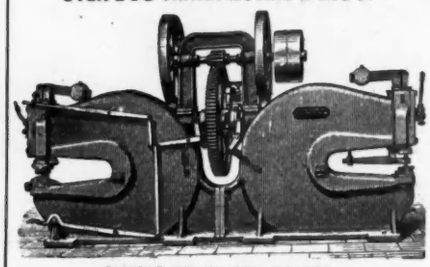

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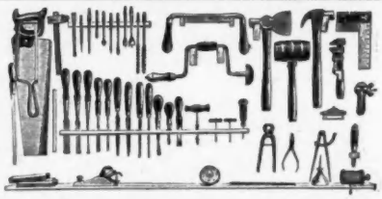

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